



Japanese Fixed Income Markets

Money, Bond and
Interest Rate Derivatives

EDITED BY

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Edited by

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*This volume is dedicated to the memory
of our dear friend and colleague Thomas A. Fetherston*

Jonathan A. Batten and Peter G. Szilagyi

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Chapter 1

JAPANESE FIXED INCOME MARKETS: MONEY, BOND AND INTEREST RATE DERIVATIVES

Jonathan A. Batten, Thomas A. Fetherston, Peter G. Szilagyi,
Editors

1. OVERVIEW

The dynamic role of capital markets (here fixed income) to efficiently channel savings funds from surplus sectors of the economy and to Finance private economic ventures which promotes Economic Growth and Economic development,¹ is a concept accepted and promoted by governments throughout the world. The role of Fixed Income Markets as an efficient tool in raising financing for Government projects (national and local) has been understood and appreciated for centuries (Homer and Sylla, 1996). The Japanese capital markets were liberalized and de-controlled after and increasingly opened to foreign participation in the 1970's. The fixed income market particularly expanded to finance the government fiscal deficits commencing in 1975. However, growth in the non-Government side of the market for Japan has been a more recent phenomenon and a goal of policymakers in Japan and Asia since 1997. The growth in this phenomenon is presented in the data section below.

These *essential characteristics* are the sine qua non of any viable fixed income market. A shortcoming in any of the important *essential characteristics* threatens the viability of that fixed income market. The *essential characteristics* are as follows:

¹ McKinnon (1973) cites the importance of cycling scarce capital in a liberal financial environment as a positive component of the development process. Although most of the countries in this work are mature countries in the development process they too can and do benefit from capital markets (Fixed Income) which enhance and promote economic efficiency.

- A rule of law;
- A primary market where new debt issues (government and private) are systematically offered;
- Investors;
- A liquid secondary market;
- Benchmark indices;
- Independent credit rating bodies;
- Interest rate derivative markets for risk management;
- At a minimum a tax neutral policy on interest payments and receipts.

The essential characteristics do not define a successful fixed income market but their absence will inhibit the growth and development of one. The *rule of law* implies nothing more than contractual relationships will be clearly understood and enforceable through normal existing legal institutions and means. A *primary market* where debt offerings for the governmental and corporate bodies are publicly announced and the procedures to participate in those offerings are fair and well understood. There should be a cadre of *investors* both institutional and private who would find the instruments offered to be suitable to their portfolio interests. The existence of a *liquid secondary market* lowers the cost of raising money in the primary as it relieves the burden of having to hold a fixed income obligation to maturity. The trading in the secondary market would be transparent and trading costs should be minimal. *Benchmark indices* (*yield curves*) are of the utmost importance for any market for pricing and to reference individual portfolio performance. The role of *independent credit rating agencies* partially relieves investors of the burden of ascertaining the ability and willingness of the borrower to repay the amount borrowed. The role and methodology followed by these independent institutions in determining their credit ratings is well understood. However, the credit rating is not a guarantee, only a guideline. Although futures and options contracts have a historical lineage centuries old, *interest rate derivatives* are a modern phenomenon. A very important ancillary function to raising fixed income capital and investing in the same is *interest rate risk management*. The interest rate derivative products first introduced in the 1970's play an integral in *interest rate risk management*. A *tax neutral policy* at a minimum will prevent a tax policy from acting as an impediment for either issuers or investors in the fixed income market. All the characteristics necessary for a successful Fixed Income Market manifest themselves in Japan.

2. JAPANESE FIXED INCOME MARKET ACTIVITY

There are three main categories of fixed income issuers as categorized by the Bank of International Settlement (BIS) data. The categories are Financial, Corporate

Table 1.1

Japanese Fixed Income Issues, 1994–2005 (billions of US Dollars).

	All Issuers ¹	Financial	Corporate	Government
1994	260.4	19.9	220.4	20.0
1995	237.6	17.8	198.4	21.4
1996	203.5	16.7	163.6	23.2
1997	316.9	111.3	182.0	23.6
1998	317.5	132.8	159.5	25.1
1999	330.9	157.3	149.9	23.6
2000	291.5	222.7	63.5	5.3
2001	261.0	206.1	50.1	4.8
2002	258.2	204.2	49.5	4.4
2003	269.3	213.3	52.0	3.9
2004	295.7	228.9	63.4	3.3
2005	287.0	223.4	60.3	3.2

¹Discrepancies between total and subtotals are due to rounding differences.Source: *BIS Quarterly Review*, various.

and Government issuers. Table 1.1 records the issuer participation in the Japanese Fixed Income markets for the period 1994 through 2005 expressed in billions of USD. The overall level of debt issuance for all issuers has risen from 260.4 in 1994 to 287.0 in 2005. The average issuance annually was 277.5 with a high of 330.9 in 1999 and a low of 237.6 in 1995. The most interesting issuance development is the changing roles of the subcategories. Financial issuers have grown from a modest 19.9 in 1994 to a high for the period of 223.4 in 2005. Corporate issuance on the other hand has slipped from a high of 220.4 in 1994 to 60.3 in 2005. The low water mark for Corporate bond issuance was 49.5 in 2002. Government issuance declined from 20.0 in 1994 to a period low of 3.2 in 2005.

Table 1.2 provides a country issuance benchmark by nationality of the issuer for the period 2003 through 2005 expressed in billions of USD. That Japan dominates the issuance market for individual countries in the Asian Pacific ex-Japan region does not surprise as Japan is second only to the US in debt issuance globally. However, the Asia Pacific block's debt issuance seems to be growing at a more rapid rate than Japan's. In the three year window Asia Pacific issuance for all three categories grew by 36.98% whereas Japan debt issuance grew by 6.57%. In the tree issuance categories (Financial, Corporate and Government) Asia Pacific issuance grew by 49.85%, 16.19% and 7.46%, respectively. Japan's three categories expanded by 4.74%, 15.96% and the government issuance of debt shrank by –15.38%.

Table 1.2

Japan, Asia Pacific and US Fixed Income Issuers.

Debt Securities by Nationality of Issuer						
	All Issuers (billions USD) ¹			Financial Institutions (billions USD)		
	Dec. '03	Dec. '04	Sept. '05	Dec. '03	Dec. '04	Sept. '05
Australia	189	255.7	274.8	160.5	225.3	248.2
China	19.7	24.5	27.2	11.3	15.9	19.2
India	3.4	6.5	9	1.3	2.4	3.1
Indonesia	9	10.3	12.6	8.4	8.9	10.1
Malaysia	23.5	28.7	29.7	10.7	16.7	18.7
New Zealand	8.8	10.5	8	3	2.9	2.5
Philippines	26.7	28.2	30.8	4.3	4.3	4.4
Singapore	22.4	30.9	34.5	13.6	20.6	24
South Korea	63.1	74.1	79.5	36.3	44.5	48
Taiwan, China	19.5	24.4	24.1	4.2	4.7	4.3
Thailand	10	10.1	11	4.6	4.2	4.4
Asia Pacific	395.1	503.9	541.2	258.2	350.4	386.9
Japan	269.3	295.7	287	213.3	228.9	223.4
United States	3,067.50	3,355.90	3,450.00	2,678.00	2,950.00	3,045.50

Debt Securities by Nationality of Issuer						
	Corporate Issuers (billions USD)			Government Issuers (billions USD)		
	Dec. '03	Dec. '04	Sept. '05	Dec. '03	Dec. '04	Sept. '05
Australia	14.8	17.2	15.9	13.7	13.3	10.7
China	2.1	1.5	1.6	6.4	7	6.4
India	2.1	4.1	5.9	—	—	—
Indonesia	0.2	0.1	0.1	0.4	1.4	2.4
Malaysia	8.3	7.4	6.5	4.6	4.6	4.5
New Zealand	2.7	2.6	2.5	3.1	5	3
Philippines	5.3	5	5.3	17.1	18.8	21.2
Singapore	8.5	10	10.2	0.3	0.3	0.3
South Korea	21.6	23.8	25.7	5.2	5.9	5.8
Taiwan, China	15.2	19.5	19.8	0.1	0.1	0.1
Thailand	2.6	2.4	3.4	2.7	3.4	3.2
Asia Pacific	83.4	93.6	96.9	53.6	59.8	57.6
Japan	52	63.4	60.3	3.9	3.3	3.3
United States	386.5	402.8	401.3	3	3.1	3.2

¹ Discrepancies between total and subtotals are due to rounding differences.Source: *BIS Quarterly Review* (2005).

Table 1.3

Japanese Fixed Income Sectors. Annual Total Returns Yen. (The annual total returns are derived from monthly total return series.)

	Corporate		Financial		Government	
	Geometric	Arithmetic	Geometric	Arithmetic	Geometric	Arithmetic
1997	4.89%	4.93%	2.69%	2.71%	6.95%	6.99%
1998	-0.04%	0.05%	0.21%	0.23%	0.46%	0.66%
1999	5.63%	5.67%	4.44%	4.46%	5.00%	5.09%
2000	1.78%	1.80%	1.33%	1.34%	2.26%	2.29%
2001	2.82%	2.83%	1.67%	1.67%	3.66%	3.68%
2002	2.75%	2.75%	1.70%	1.71%	3.81%	3.82%
2003	-0.10%	-0.08%	0.52%	0.53%	-0.97%	-0.92%
2004	1.51%	1.52%	1.34%	1.34%	1.27%	1.30%
2005	0.51%	0.52%	0.31%	0.32%	0.83%	0.84%
σ	2.047%	2.044%	1.332%	1.333%	2.491%	2.479%

Source: Merrill Lynch Global Indices.

The annual total return results for the three segments of the Japanese fixed income markets are presented in Tables 1.3 and 1.4. The Yen returns for the Corporate, Financial and Government bond sectors are presented in Table 1.3. The total return results are presented in geometric and arithmetic terms for the years 1997 through 2005. The total returns in Yen for the Corporate sector are negative (geometric) for two of the nine years and negative (arithmetic) for one year of the 1997–2005 period. The total returns for the Financial bond sector are positive throughout the period. The Government bond sector has one negative total return (geometric and arithmetic) year in 2003. The standard deviations of returns range from a low of 1.33 (geometric and arithmetic) to a high of 2.49 (geometric) in the Government sector. A benchmark for both the return and risk measures are the data drawn from *Triumph of the Optimists*, by Dimson, Marsh and Staunton (2002) (DMS)² which includes bond return measures for Japan. The long term study (1900–2000) of DMS found geometric returns of 5.9% and arithmetic returns of 6.9% with a standard deviation of 14.9. The DMS study has significantly higher returns and higher risk than the shorter nine years (1997–2005). The shorter period has annual geometric total returns of 2.10% and arithmetic

²

Japan Fixed Income Markets 1900–2000			
Annual bond total returns		Risk measures	
Geometric	Arithmetic	Standard error	Standard deviation
5.90%	6.90%	1.50%	14.90%

Source: Dimson, Marsh and Staunton (2002).

Table 1.4

Japanese Fixed Income Sectors. Annual Total Returns USD. (The annual total returns are derived from monthly total return series.)

	Corporate		Financial		Government	
	Geometric	Arithmetic	Geometric	Arithmetic	Geometric	Arithmetic
1997	-6.47%	-5.76%	-8.65%	-7.93%	-4.43%	-3.74%
1998	14.28%	16.28%	14.53%	16.60%	14.78%	16.73%
1999	15.41%	15.79%	14.22%	14.58%	14.78%	15.21%
2000	-9.11%	-8.50%	-9.56%	-8.97%	-8.64%	-8.01%
2001	-10.93%	-10.20%	-12.07%	-11.33%	-10.10%	-9.40%
2002	12.74%	13.03%	11.69%	11.96%	13.81%	14.12%
2003	10.12%	10.26%	10.75%	10.89%	9.24%	9.40%
2004	6.01%	6.52%	5.83%	6.34%	5.77%	6.30%
2005	-13.55%	-13.39%	-13.74%	-13.59%	-13.23%	-13.07%
σ	11.072%	11.126%	11.476%	11.543%	10.607%	10.684%

Source: Merrill Lynch Global Indices.

total returns of 2.15%. The comparison of the two partially overlapping periods does not lend itself to critical introspection other than the obvious differences. Extreme liquidity creation by the Bank of Japan along with relatively low levels of interest rates in the major global financial markets for 1997–2005 term may explain the differences.

The risk borne by non-Yen-based investors in the Japanese Fixed Income market is demonstrated in Table 1.4. Over the same 1997–2005 period the USD total returns from investing in the three Japanese Fixed income sectors produced negative (geometric and arithmetic) in four of the nine years. The geometric result for the entire period (1997–2005) across the three sectors was 1.36% and the arithmetic result was 2.6%. The standard deviation of returns in USD is significantly higher than that of the Yen based results. The currency risk for USD based investors significantly increases the risk of investing in Yen denominated fixed income vehicles.

Whether from a Yen or non-Yen investor perspective the existence of an interest rate derivative market is imperative to fulfilling any interest rate risk management scheme. Table 1.5 provides data for the term June 2003 through June 2005 on OTC Interest Rate Derivative Contracts. The annual average notional value of all OTC Interest Rate Derivative contracts for the period is USD 164,662. The breakdown for contracts is Forward Rate Agreements (USD 12,1090), Swaps (USD 129,548) and Options (USD 23,005). The average annual OTC Interest Rate Derivative market share by currency is Yen 12.83%, USD 33.59%, Euro 39.20% and all others 9.20% (see Figure 1.1). The average annual percentage share during

Table 1.5
OTC Interest Rate Derivatives (by Instrument and Currency).

Instruments	Notional amounts (billions USD)				
	2003 June	2003 December	2004 June	2004 December	2005 June
Total contracts	121,799	141,991	164,626	190,502	204,393
Forward rate agreements	10,271	10,769	13,144	12,788	13,573
%Market share	8.43%	7.58%	7.98%	6.71%	6.64%
Swaps	94,583	111,209	127,570	150,631	163,749
%Market share	77.65%	78.32%	77.49%	79.07%	80.11%
Options	16,946	20,012	23,912	27,082	27,071
%Market share	13.91%	14.09%	14.53%	14.22%	13.24%

Currencies	Notional amounts (billions USD)				
	2003 June	2003 December	2004 June	2004 December	2005 June
All currencies	121,799	141,991	164,626	190,502	204,393
Japanese yen	15,270	19,526	21,103	24,209	25,224
%Market share	12.54%	13.75%	12.82%	12.71%	12.34%
US dollar	40,110	46,178	57,827	61,103	72,156
%Market share	32.93%	32.52%	35.13%	32.07%	35.30%
Euro	50,000	55,793	63,006	76,161	76,426
%Market share	41.05%	39.29%	38.27%	39.98%	37.39%

Source: *BIS Quarterly Review* (2005).

the 2003–2005 period by *instrument* from Table 1.5 is Forward Rate Agreements 7.47%, Swaps 78.53% and Options 14.19% (see Figure 1.2). The notional values for Exchange listed Interest Rate Derivative Contracts are exhibited in Table 1.6. The two instrument categories are Futures and Options. The notional values are significantly smaller in the listed market than in the OTC market. Table 1.6 does not provide data directly on the Yen market as it is subsumed in the data from the Asia and Pacific category. For comparative purposes we see from Table 1.5 that the Yen makes up 12.83% of the OTC Interest Rate Derivative Market but has a smaller representation in the Listed Derivative Markets (Table 1.6). Asia and Pacific as a subset represents only 11.7% of the notional interest rate Futures contracts outstanding over the period December 2002–September 2005. Listed Interest Rate Options notional value for the Asia and Pacific region comprises only 0.16% of the value outstanding for the period. Clearly the action for Interest Rate Derivative contracts for the Yen is in the OTC market.

Table 1.6

Interest Rate Derivative Instruments Traded on Organized Exchanges by Instrument and Location.
(Notional principal in billions of US dollars.)

INSTRUMENTS/ LOCATION	Amounts Outstanding			
	2002 Dec.	2003 Dec.	2004 Dec.	2005 Sept.
Futures				
All markets	9,955.60	13,123.70	18,164.90	19,860.30
North America	5,660.10	7,384.60	10,043.60	11,209.00
Europe	3,163.50	4,200.20	5,756.10	5,908.20
Asia and Pacific	1,037.10	1,395.40	2,208.00	2,506.10
Other Markets	94.9	143.4	157.2	237
Options				
All markets	11,759.50	20,793.80	24,604.10	32,794.90
North America	6,660.60	10,381.80	15,286.70	21,805.10
Europe	5,049.70	10,357.20	9,282.00	10,925.70
Asia and Pacific	44.3	44.2	13.7	44.5
Other Markets	4.9	10.6	21.7	19.6

Source: *BIS Quarterly Review* (2005).

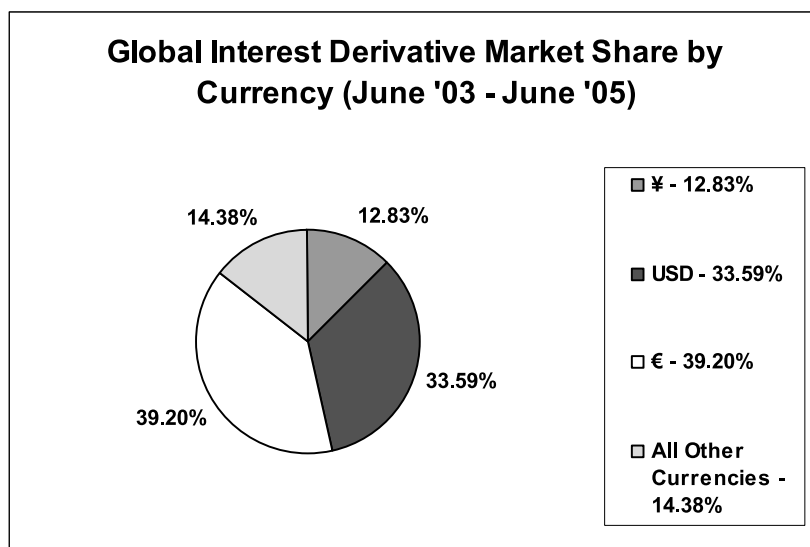


Fig. 1.1.

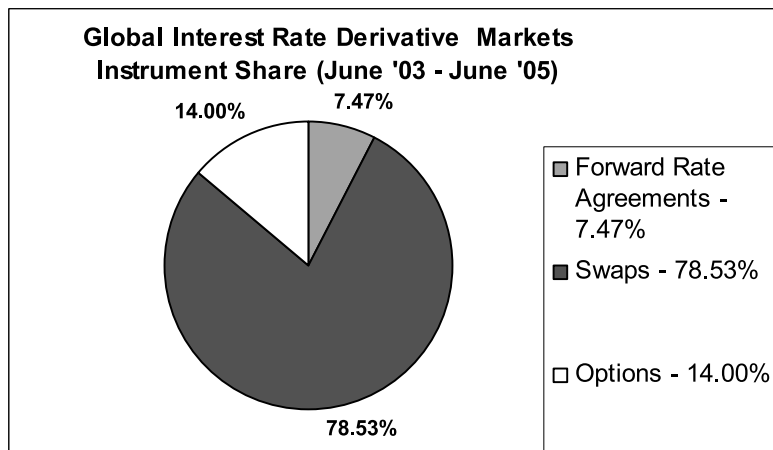


Fig. 1.2.

3. STRUCTURE OF THE VOLUME

The efforts of the authors who have contributed to this volume will measurably add to understanding of the Japanese Fixed Income Market. This volume is structured into four parts: *Macroeconomic Environmental Development*, *Credit Risk Measures and Management*, *Interest Rate Analysis* and *Market Integration* sections.

There are seventeen chapters in the volume with thirty-one authors, many of whom are prominent in academic and practitioner aspects of the Fixed Income markets field, contributing their insight to this volume.

3.1. *Macroeconomic Environmental Development*

The **Szilgyi** paper recounts the latest trends in Japan's corporate bond market. It also draws light on the persistent weaknesses in the corporate market, which are continually discussed by analysts and academics like (Schinasi and Smith, 1998; Kuratani and Endo, 2000; Hattori, Koyama and Yonetani, 2001; Rhee, 2001; Baba and Hisada, 2002; Batten and Szilgyi, 2003). The market's on-going evolution conceals the fact that its contribution to efficient resource allocation continues to be limited. Only large, credit-worthy firms have turned to bond issuance, which are equally desirable bank clients but are trying to untie close banking relationships. The lower end of the market has failed to take off altogether. Non-

investment-grade firms are simply priced out, often leaving them cash-strapped thus hurting the growth prospects of the Japanese economy.

The lack of development in the junk-grade segment is largely driven by the unfavorable structure of demand in the market. More than three quarters of corporate bonds are held by banks and insurance and pension funds, which typically follow a no-junk investment eligibility rule. Retail holdings remain minimal, while investment trusts have been slow to develop. These patterns are symptomatic of the extreme risk aversion of Japanese households, which continue to put the bulk of their savings into bank deposits, creating a massive excess liquidity problem in the banking sector.

A final hindrance to market development is that the Japanese market is still not strong, diverse or efficient enough to counter competition from the Euroyen market. As a result, the Euroyen market has been increasingly diverting issuance from domestic firms, and continues to undermine the *Samurai* market intended for non-resident borrowers. This is a non-trivial matter, since a pickup in Samurai issuance in particular could boost domestic issuance in the junk segment, as well as ease the liquidity trap burdening the Japan's financial system. Szilzgyi asserts that there remains room for further development in practically all areas. Necessary infrastructural enhancements include even greater market liquidity, the reduction of price distortions, better disclosure and the strengthening of market surveillance. There is room for improvement in corporate governance, and the market for corporate control should be activated. More generally, it is imperative that a diverse and multilevel investor base be developed with the assistance of both lawmakers and regulators. The internationalization of market participants is all but a key element of this strategy, which demands the improved competitiveness of the Japanese market in the global setting.

Traditionally, Japan has been a country of indirect financing through banks, but the massive non-performing loans and *kashishibori* (reluctance of banks to lend money) problems, that have crippled the financial system and economy in general since the bubble economy burst, have pushed Japan more towards direct financing sources, especially securitization. Securitization, which is a financing technique based on the risks and returns associated with assets, allows financial institutions and companies with poor credit ratings to effectively access funds in capital markets.

The aim of the **Coman** paper is to paint the "big picture" of the securitization of markets in Japan. It outlines the legislation enacted to create the market, how the market has subsequently developed and where it is headed in the future. It also highlights the problems experienced in establishing the market, issues to be solved for its future development, the cultural background and distinctive characteristics

of the market and the role that the market is playing in improving the health of financial institutions and the overall Japanese economy.

Following the bursting of the bubble economy in 1991, the financial system became crippled by non-performing loans that stemmed from over zealous lending practices during the bubble era. By the mid-1990s, Japan had started to experience failures of financial institutions, which is something that the Japanese financial system had been successful in preventing until then through its convoy system (*gososendan hoshiki*), where strong banks would support weaker banks to prevent bankruptcies from surfacing. By the mid-1990s the problem was worsening and serious measures were required to deal with the problems inherent in the system as non-performing loans kept piling up and banks became more and more reluctant to lend money; a problem referred to in Japanese as “*kashishibouri*”. It was also apparent that Japan was declining rapidly in importance as an international financial centre. This led to the big bang reforms introduced by Prime Minister Hashimoto in 1996 to make the Japanese financial market “free, fair and global” by 2001. The creation of a securitization market to revitalize the real estate market and dispose of non-performing loans was one of the aims of these reforms and included the enactment of three pieces of legislation for perfecting loan assignments, special purpose vehicle (SPV) and servicing. As Japan is a country which values conformity through the creation of laws and regulations, legislation was enacted in several stages to create the market and reflects the problems inherent in the financial system at the time of enactment. The front-runner of securitization legislation was the Specified Claims Law which was enacted to provide lease and credit companies’ greater access to funding sources upon the bursting of the bubble economy. The author points out that while most securitization markets around the world began from securitization of home loans, the enactment of the Japanese legislation meant that the securitization market in Japan began from securitization of lease and credit claims.

The **Young and Chin** paper’s focus is on the financial derivative markets in Japan and the Yen-based products traded outside of Japan. The demand for interest rate derivative products tends to be driven by the size of a country’s government security and bond markets, the use of local currency denominated fixed interest securities offshore, and by the underlying volatility in interest rates. The major interest rate derivative trading in Asia takes place in Singapore and Japan. For Japan the main interest is local but Singapore provides a successful market for international interest rate derivatives, in particular the Eurodollar and Euroyen interest rates. The fact that Japanese Yen are traded in such large volume in the Eurocurrency markets has led to very significant interest rate derivative trading in Euroyen and Japanese Government security-based products in both the United States and London in particular. The Tokyo Stock Exchange launched the first

financial futures contract in Japan on October 19, 1985. This was the 10-year Japanese Government Bond Futures contract and it was introduced to meet the need from market participants to have a tool to manage interest rate risk. This product remains one of the most actively traded financial derivative products on the Tokyo Stock Exchange and an equivalent options product is also available. The other major contracts traded here are the equity index futures and options products on the TOPIX stock index. For the year 2004, the Government Bond contracts accounted for approximately 47% of the total contracts traded while the TOPIX contracts accounted for approximately 53%. While the Tokyo Stock Exchange focuses on its long-term interest rate contracts, the Tokyo International Financial Futures Exchange (TIFFE) focuses on short-term interest rate contracts and interest rate swap contracts. This exchange began trading in 1989 and then in 1996 entered into an agreement with the London International Financial Futures and Options Exchange (LIFFE) to trade the three-month Euroyen interest rate contract. The links between TIFFE and what is now Euronext-LIFFE were further strengthened when, in 2003, an agreement was reached for TIFFE to use Euronext LIFFE's trading platform, LIFFE CONNECT®. By far the major contract traded on the Tokyo International Financial Futures Exchange is the three-month Euroyen interest rate contract. For 2004 trading in this contract made up approximately 95% of total contract trades. When considering future trends in derivative markets, the three areas to consider are the growth potential, the forces at work for market integration, and the future demand for the products being trading and likely new products that could come to the market.

The **Jerram** piece explores the deflationary experience of Japan since 1990 and its implications for bond yields, asset prices and overall economic performance. The author addresses the question whether Japan's weak growth and deflation were avoidable. Jerram argues that most of Japan's problems reflect poor economic management and the lack of a suitable policy response to correct the distress caused once the bubble had burst. As such, most of the lessons from Japan are of the "how not to" variety. Bond market participants need to consider not just whether Japan's experience has relevance for other markets, but also whether it relates to the outlook for Japanese fixed income markets. The author looks at three broad schools of opinion of the cause of the persistent deflation and poor performance in the post-bubble era. These are labeled "structural", "financial system" and "demand management". According to the structural school, Japan experienced a productivity shock in the early 1990s, to which the suitable response was structural reform to raise potential growth. This chapter will argue this is not a persuasive argument. The financial system explanation is that the collapse of the 1980s bubble caused balance sheet distress at the banks and the corporate sector, resulting in credit constraints and mis-allocated resources. The lack of a policy

response—unlike other developed economies that suffered comparable distress—resulted in a prolonged workout of the problem and poor growth.

The demand management school argues that Japan's basic problem was a large output gap and the need for fiscal and monetary stimulus to boost growth. Premature attempts at fiscal consolidation by the Ministry of Finance (MOF) and reluctance by the Bank of Japan (BOJ) to pursue a sufficiently aggressive monetary policy condemned the economy to a decade of deflation. In effect, Japan has been unable to escape from a Keynesian liquidity trap, due to a lack of demand stimulus by policy makers. Jerram's argument is that a combination of the financial system and demand management explanations are the most persuasive explanations. Moreover, the general belief among policy-makers that the causes of poor performance were structural resulted in policy measures that lacked relevance, and at times even exacerbated the problems. Jerram asserts that the political focus on structural problems had the result of producing a policy focus on peripheral issues such as deregulation. More seriously, it also led to active policy mistakes, such as premature fiscal and monetary tightening. These were the natural consequence of the focus on structural problems as the cause of low growth, which implicitly led to an underestimation of the size of the output gap. An incorrect diagnosis of the problems also raises the prospect of continued policy error, as do institutional problems in the process of formulating policy. The main area of hope for Japan avoiding a recurrence of the problems of the 1990s is that financial system regulation has been steadily tightened. This should prevent another bout of forbearance, where the accounting version of banks' loan books is allowed to diverge significantly from the economic value. Low core profitability implies some risk for banking system health, but any problems would quickly become apparent, rather than remaining hidden with the damage to economic performance that this entailed. Other developed economies seem relatively unlikely to share Japan's experience. Policy making is generally better, financial system regulation is stronger and political processes involve more accountability than Japan in the 1990s. As a result, the weak growth and deflation of the fifteen years after the bubble burst should go down as a unique and unnecessary period of history, rather than a warning of what is to come elsewhere.

The **Werner** paper looks at the many attempts by researchers from various schools of thought to deal with the question of why interest rate reductions failed to stimulate a lasting recovery in Japan during the 1990s. He concludes that none of the studies has found a satisfactory answer to the question, which is clearly supported by empirical evidence. This finding means that the Japanese macroeconomic experience of the 1990s poses a fundamental challenge to established economic theories. Since Japan is the second-largest economy in the world, this challenge should serve as stimulus to economists to either refine their theories

further, or tread on alternative paths. Despite this finding, this survey has also made clear that many interesting insights have been gained from the wide literature surrounding Japan. Indeed, the differing schools appeared to have a different 'comparative advantage' in successfully highlighting specific important aspects of the monetary process in Japan. Proponents of one school will recognize that other schools of thought have some insights to offer. This suggests that perhaps future research should take the direction of eclectic models that attempt to combine different aspects and insights from different schools of thought. The idea that credit rationing and the problems of the Japanese banking system have been a core issue hampering a sustained recovery has become more widely accepted. However, he asserts, even this argument needs further refinement. It has remained limited to microeconomic aspects and a clearer link to macroeconomic models remains to be established. This is an issue of importance for monetary economics in general: while models with micro-foundations or microeconomic models of market failure have made advances, much work remains to be done to link them into macroeconomic theories. It appears that the role of banks as the bridge between the micro and macroeconomic levels is crucial. This has been recognized by a number of researchers. Thus further work seems needed on the question of why banks might be 'special'. More generally, this survey has demonstrated that much time and effort can be spent on ultimately fruitless work in building models. He states an important lesson of how the economics community has dealt with the Japanese challenge should therefore be in terms of scientific research methodology. So far, deductive models, based on axioms and assumptions, have been dominant. This may be fruitful and has serious advantages, if the models created in this way continue to be congruent with reality. Their weakness is that once discrepancies between theory and reality ('anomalies') are observed, the deductive approach does not offer any guidance on how a model should be adapted. Thus a process of trial and error follows, whereby different researchers propose different deductive models, and then test whether they fare better empirically. This, however, is not the most efficient research methodology to advance knowledge. Perhaps this is an area where economists can learn much from natural scientists. In their disciplines, it has become well established that the inductive research methodology provides for a more effective approach in identifying theories and models of how the world works. According to the inductive method the researcher, as objective bystander, maintains no prejudice concerning the relevant theory, but instead first begins by analyzing the data, in the search for patterns that fit the data. Based on a sound understanding of empirical reality, attempts are then made to formulate models that may fit the data (thus involving some deductive work, which is, however, subordinated to the empirical facts). According to this approach, any restrictive assumption must be justified, as the fundamental principle of parsimony indicates

that a simpler model (with fewer restrictive assumptions) is preferable to a more complex model. A first step in this direction was made by Werner (2005): where a parsimonious macroeconomic model, dependent on fewer assumptions, is suggested which is grounded in empirical reality. It can explain what traditional approaches could explain, but also the numerous ‘anomalies’ that traditional models could not account for. This includes the puzzle of the ineffectiveness of interest rate reductions in Japan.

3.2. Credit Risk Measures and Management

The **Pynnönen, Hogan and Batten** study specifies an equilibrium correction model of the credit spreads on quality Japanese yen Eurobonds. The strategy of the paper is to start off with an unrestricted setup using vector autoregression (VAR) of the important factors found in the earlier papers, particularly in Batten, Hogan and Pynnönen (2003), and proceed to identify the crossdynamics between the series. The obvious advantage of this approach is that they can identify the important feedback relations between the credit spread and related main factors. This allows them to determine the time lags in the adjustment process to the equilibrium once shocks have driven the yields out of the equilibrium. There is surprisingly much evidence that the credit spreads, measured in terms of yield differences over the corresponding government bonds, per se are non-stationary (for example Pedrosa and Roll, 1998; Mansi and Maxwell, 2000). In spite of these, it is fairly implausible that the yields could wander without bounds apart from each other in the long run. This was also confirmed in Pynnönen, Hogan and Batten (2006), where strong evidence was found for stationarity of the AA and AAA rated Yen Eurobonds. Pynnönen, Hogan and Batten (2006) find that the most important factor driving the credit spread changes, as predicted by Longstaff and Schwartz (1995), is the changes in the risk-free rate. On the other hand the second important factor, firm asset return, implied by the Longstaff–Schwartz model did not show as being statistically significant. The reason for this may be that the stock market general index returns, that are usually utilized as proxies for the firm asset returns, do not properly reflect the true asset position, particularly when restricted to AA and AAA rated bonds. The other important factor found in Pynnönen, Hogan and Batten (2006) was the change in the slope of the term structure of Japanese government bonds proxied by the change in the yield spread of 20 year and 2 year bonds. Two other factors were the cointegration relation (spread), and conditional volatility of the spread changes. The importance of the conditional volatility as an explanatory variable in the mean equation of credit spread changes is again a factor that is not predicted by the theoretical model by Longstaff and Schwartz (1995). However, Engle, Lilien and Robins (1987) find that the excess

yield of the long bond depends on the conditional variance rather than being a constant. The empirical results of Pynnönen, Hogan and Batten (2006) indicate also that the conditional volatility is potentially an important factor in determining the credit spreads. The Longstaff and Schwartz (1995) model predicts that asset return volatility should be an important determinant of the credit spread. In the case of the corporate bonds it may well be that the conditional volatility of the credit spread replaces the more traditional stock return volatility as a surrogate for the firm asset return volatility. Utilizing these findings they focus on dynamic modeling of the equilibrium relation of credit spreads on the yen Eurobonds. The paper contributes to the existing literature by specifying the dynamic structure of the equilibrium correction and identifying the important feedback links between the factors related to the credit spreads.

The **Bystrom** paper focuses on the largest of the various credit derivatives markets, the credit default swap (CDS) market, which is a market for insurance against credit events (bankruptcy, restructuring, delayed debt payments, etc.). In 2004, an important step was taken in the history of the global credit markets when *Dow Jones* and *International Index Company* (a company owned by the major global investment banks) merged two earlier families of CDS indexes into one single liquid and tradable family of CDS indexes called *Dow Jones iTraxx* indexes in Europe and in various Asian-Pacific markets. In the US, similar *Dow Jones CDX* indexes were also introduced in 2004 by the same companies. All these indexes represent portfolios of single-name CDS contracts and they all allow investors to buy or sell market-wide credit risk in one transaction. The *iTraxx* and *CDX* indexes are highly liquid and transparent instruments that establish credit as its own asset class and this has attracted investors from all sectors of the financial market. The most important determinant of the value of a credit default swap, and consequently of a credit default swap index, is the probability of the underlying (reference) firm(s) being exposed to a credit event at some future point. This probability is hard to determine exactly but extensive work in the field of default probability modeling is continuously making default forecasts more accurate. These models rely on the efficient market hypothesis to hold for the stock market and the most well known approach of calculating the default probability of a firm (and the credit spread of the firm's debt) using information from the stock market is the Merton (1974) model.

In this paper he looks at market wide credit protection in Japan; i.e. the issue of how to hedge against a general credit deterioration in corporate Japan. The easiest, if not only, way of doing this is to turn to the credit default swap market and in this paper our goal is to assess the effectiveness of this particular market in Japan. More exactly, he investigates whether the newly introduced *iTraxx CJ* index of credit default swaps is behaving in a way consistent with theory and whether it

can be used to protect the investor against overall credit risk in the Japanese corporate sector. In order to do this he draws on earlier theoretical research, Merton (1974), where the value of a firm's stock and the volatility of its stock returns are suggested to be the main determinants of the firm's credit risk. He interprets the term "firm" in an aggregate sense and create a stock portfolio containing the same firms as the *iTraxx CJ* index and calculate correlations between this portfolio's value and volatility and the CDS index spread. He also investigates whether the valuation and volatility of the market-wide *Nikkei 225* index is correlated with the 50-firm based *iTraxx CJ* CDS index. Overall, he finds the various correlations large enough to lend support to the hypothesis that the *iTraxx CJ* CDS index can be used as a possible hedge against market-wide Japanese credit risk even in the case when the underlying firms in the market-wide portfolio is not identical to those in the CDS index itself. The results in this study can be compared to earlier studies on the *iTraxx* market in Europe where Byström (2005a, 2005b) found a close relationship between both the value and the volatility of stock portfolios in various industrial sectors and corresponding *iTraxx* indexes.

The credit derivatives market is arguable one of the fastest growing financial markets. The growth of the market and variety of credit derivative assets being traded means it is important that the underlying characteristics of credit spreads themselves are well understood. The focus of the **Ellis and Hogan** study is the distribution of credit spreads between AAA and AA rated yen denominated Eurobonds and the equivalent Japanese Government bonds. They consider maturities of 2-, 3-, 5-, 7-, 10- and 20-years for the period from 9 January 1993 to 21 October 1998. Japanese government bond issues are traditionally at a fixed rate with maturities from 2-years to 20-years, though most domestic market issues have a maturity of 10-years (Pynnönen, Hogan and Batten, 2002).

Previous studies of credit spreads have focused largely on the term structure of credit using first structural models derived from Merton (1974), and later using reduced-form models introduced by Duffie and Singleton (1997). A comprehensive review of studies using both types of model is given in Meng and Gwilym (2005). Recent studies evaluating forecasts of credit spreads and of spread volatility include Sueppel (2005) and Johnson and Batten (2003). The distribution of US credit spreads is considered by Pedrosa and Roll (1998) and of AUD denominated spreads by Phoa (1999) however comparatively little is known about the distribution of yen denominated spreads. The primary objective of this study is to provide an understanding of the distributional qualities of yen denominated credit spreads. They first measure the moments of the distributions of the various credit spread series, and then examine different distributional models which may be consistent with the observed spread distributions. Our results provide strong evidence in favor of the yen credit spread series conforming to a mixture of two

Normal distributions. The data employed in this study comprises aggregated bond yields for two different ratings classes of yen denominated Eurobonds bonds (AA and AAA rated) and government bonds with maturities of 2-, 3-, 5-, 7-, 10- and 20-years over the period 9 January 1993 to 21 October 1998—a total of 1382 observations for each bond issue. The authors find strong support for the hypothesis that credit spreads conform to a mixture of two Normal distributions model. Compared to findings for a mixture of n Normal distributions, the mixture of two Normal distributions model is shown to have at least the same descriptive power. Their findings with respect to the mixture of two Normal distributions model are furthermore consistent with our simulated results for skewness and kurtosis.

The purpose of **Fairchild and Shin** contribution is to provide insight into the credit rating environment of Japan. Japan's public debt market is internationally prominent due to its size and rapid growth. Hence, knowledge about the credit rating environment of this market is important. This study based on a survey of Japanese firms is the first international credit rating survey focusing solely on Japanese issuers and rating agencies. Previous surveys on credit ratings target firms in a specific industry (Ellis, 1998) or country, in particular, the U.S. (Baker and Mansi, 2002). Although Cantwell (1998) surveys 1,800 issuers in the U.S. and 50 foreign countries for their opinion on international rating agencies such as Moody's, S&P, and Fitch, he neither goes into detail about the issuers in foreign countries nor scrutinizes Japanese rating agencies. Moreover, no prior survey investigates the opinion of issuers rated by a specific rating agency. Their survey focuses on Japanese firms rated by Moody's because prior evidence suggests that Japanese firms consider Moody's to be the most influential rating agency in Japan. The Fairchild and Shin survey also highlights unsolicited ratings because unsolicited ratings are a controversial topic in the credit services industry. U.S. issuers are bitterly complaining about them and a Colorado school district sued Moody's for issuing unsolicited ratings. The existing evidence of Ellis (1998) and Baker and Mansi (2002) indicates that most U.S. issuers want rating agencies to identify unsolicited ratings clearly. Similar to U.S. firms, Japanese firms are also reportedly very dissatisfied with unsolicited ratings. The results of their survey indicate that firms with unsolicited ratings have considerably different opinions on rating agencies when compared to those of firms with solicited ratings. For instance, firms with unsolicited ratings are very happy with the performance and rating practices of Japanese agencies while highly dissatisfied with those of U.S. agencies. However, Japanese firms with solicited ratings do not discriminate against U.S. agencies in their evaluation of rating agencies. Additionally, all of the respondents, whether they have unsolicited ratings or not, hired at least one more agency in addition to Moody's. In particular, firms with unsolicited ratings pre-

ferred Japanese agencies to U.S. ones when they hire additional agencies, even though firms with solicited ratings do not have any preferences.

The **Yamori, Nishigaki and Asai** work aims to explain the current role and issues of credit ratings in the Japanese bond market. They point out the increasing role that credit ratings are playing in Japan. However, their focus is on the problems with ratings that remain to be solved. One issue concerns American raters in Japan. In Japan, American raters are strongly criticized because people suspect that Moody's and S&P assign inappropriately low ratings to Japanese issuers. The actual default rates in the Japanese market do not seem to support these low ratings. Annual data released by Moody's and S&P show that their ratings are closely related with actual default ratios, but this only means that their ratings of U.S. companies are closely related with actual default ratios, and does not mean that their ratings of Japanese companies are also closely related with actual default ratios. Japanese managers are often unsatisfied with the reasons given for downgrading by American raters, because they feel that American raters do not understand business practices in Japan. For example, according to Fight (2003), Moody's degraded the rating of Toyota Motor Corporation from AAA to Aa1 in 1998 on the grounds that competition in the global automobile market is intensifying, and Toyota's competitiveness has weakened due to its practice of giving workers lifetime employment. In refuting Moody's, Mr. Okuda, the CEO of Toyota Motor Co., argued that the lifetime employment system was not a burden for Toyota because it had adopted a flexible employment structure. Eventually, Moody's upgraded Toyota's rating from Aa1 to AAA in 2003. Furthermore, Fight (2003) pointed out the fact that none of twenty-five Japanese corporations that Moody's assigned speculative grades to before 1998 had defaulted as of October 2003, while the probability that firms rated Ba by Moody's would default within five years was 11.4 per cent. He pointed out that Moody's might have disregarded specific factors in the Japanese market (e.g., mainbank relations) which lower default rates. There are also deep-rooted complaints against "unrequested ratings" by U.S. agencies in the Japanese bond market. In terms of unrequested ratings, there is a slight difference between S&P and Moody's. S&P clearly distinguishes "requested" and "unrequested" ratings for investors because investors recognize that unrequested ratings rely on less information or less reliable information than requested ratings. In contrast, Moody's insists that they are able to maintain the same quality for unrequested ratings as requested ones, so Moody's doesn't disclose the distinction at all.

Although there is considerable evidence that American raters are not always right, there are also serious problems with Japanese raters. Except for Mikuni & Co., Japanese credit rating agencies are not independent from issuers and financial institutions. Namely, JCR and R&I are still substantially capitalized by

financial institutions. In addition, these Japanese raters earn rating charges only from issuers. In other words, investors are not the customers of these raters. In fact, except for Mikuni, Japanese raters tend to assign better ratings to Japanese issuers than American raters. It is necessary to investigate whether the capital structure and business practices of Japanese raters distort their rating decisions. Finally, they point out that Japanese investors may not fully understand the meaning of rating grades. The Japanese mass media often state that a rating below BB+ is considered an “inadequate to invest” grade, not a “speculative grade”, and Japanese investors also accept this interpretation. Therefore, in the Japanese market, once a firm is rated below BB+, the firm can no longer obtain necessary funds. However, “a speculative grade” doesn’t mean that people shouldn’t purchase the firms’ bonds, but just means that there are relatively high risks to purchasing the bonds and a high expected return. Therefore, Japanese investors need to be educated on how to use credit ratings properly. Thus, although credit ratings play a very important role in Japan, much remains to be done before credit ratings can be considered reliable and before they can be properly used in Japan.

3.3. Interest Rate Analysis

The **Jamdee and Los** effort attempts to extend and build on existing and received interest rate model analysis. Accumulating evidence in the academic financial literature indicates that these Generalized Brownian Motion Models (GBMs) cannot explain several salient features of the empirical financial data. Following Engle’s (1982) Auto-Regressive Conditional Heteroskedasticity or ARCH model, Bollerslev (1986) proposed the Generalized ARCH or GARCH model to explain the empirically observed time-varying volatility of financial market pricing processes, driven by i.i.d. information processes. The authors suggest that the users of the GARCH model experience serious difficulties with the identification of its proper lag orders. Practically, the GARCH(1, 1) model is now very common in financial time series modeling, but that is mainly due to its overreaching simplicity. Although it captures skewness and kurtosis phenomena in addition to time-varying volatility, the GARCH model does not identify other important phenomena of empirical financial data, such as time-frequency scaling and long-range dependence, or “Long Memory”. With the objective to mitigate some of the drawbacks of both the GBM and GARCH(1, 1) models, Jamdee and Los use the Multifractal Model of Asset Return (MMAR) of Calvet, Fisher and Mandelbrot (1997) as a viable and empirically satisfying substitute to model each of the eight nodal interest rates of the Japanese term structure. In their approach, each of the nodal interest rates is modeled as a multifractal Brownian motion, driven by a multifractal information process instead of by an i.i.d./Wiener–Gauss information process. In fact,

this paper implements the MMAR for the first time as the diffusion process of the Japanese Treasury monthly interest rate series for various maturities and compares its performance with that of the affine GBM and GARCH models. Monte Carlo simulations are used for model performance measurement, in the sense that the identified models are required to reproduce the identified characteristics of the empirical Japanese interest rate series. It should be recognized that this paper does not attempt to price any Japanese bonds. Rather, the paper focuses on the analysis of simulated fractal price diffusion processes of the nodal market interest rates of the Japanese term structure. The identified dynamic term structure of interest rate processes can then be used to price bonds, via the conventional bond pricing formulas. The data are monthly Japanese Treasury interest rate series provided by the Capital Markets Function of the Federal Reserve Bank of New York, which obtained them from the Bank of Japan. No higher frequency of Japanese interest rate series is currently available to academic researchers. This paper uses the monthly computational interest rate series with 6-month, 2-year, 3-year, 4-year, 5-year, 6-year, 10-year, and 20-year maturities. The interest series in this study cover the period of January 1987–August 1997. This approximate 11-year period provides only 128 monthly observations, severely hampering the achievable accuracy of the model identification. This length of the data set is necessarily chosen such that it follows Los (2003)'s suggestion about business cycles that last approximately 10 to 12 years. Each interest rate series for any maturity has the same number of observations. The main finding of this paper is that the Japanese interest rate series from the 6-month to 20-year maturities show mild anti-persistence overall, with the exception of the 20-year maturity interest rate, which shows severe anti-persistence in the range of possible chaos. This happens despite the fact some of the trading clustering can be shown to be persistent. This finding surprised us and therefore will lead to more research in the future with higher frequency data, which are not yet available for these Japanese interest rate series. In addition, our simulations of the empirically identified models suggest that the MMAR might not always be superior to the GBM and GARCH(1, 1) processes in modeling the time-scaling characteristics of the Japanese monthly interest rate series, because it experience difficulties with reproducing the proper degree of anti-persistence.

The **Nowman** work explores and extends the extant modeling of Japanese interest rates. The use linear and nonlinear continuous time models for in Japanese fixed income financial markets has been an important research area in finance given the size of the Japanese bond and derivative markets. Various approaches have been developed in the literature for estimating the parameters of these interest rate models. One common estimation approach is the Generalized Method of Moments method by Hansen (1982) which has been employed on single fac-

tor models using a discrete time approximation. This is the approach adopted in the important study of Chan, Karolyi, Longstaff and Sanders (1992, CKLS, hereafter). Applications to Japanese interest rates include for example, Tse (1995) and Hiraki and Takezawa (1997). An alternative approach to estimating nonlinear single factor models using an alternative discrete approximation was proposed by Nowman (1997). This discrete approximation was based on the exact discrete model that was suggested and explored in Phillips (1972) for estimation of continuous time models with discrete data (see also Bergstrom (1984)). Nowman (1997, 1998, 2001, 2002, 2003), Nowman and Sorwar (1999), and Nowman and Níguez (2005a) used Gaussian estimation econometric methods which were first developed in a series of papers by Bergstrom (1983, 1984, 1985, 1986, 1990). These Gaussian estimation methods were applicable to general linear continuous time models and Nowman (1997) extended their applicability to nonlinear interest rate models involving heteroscedasticity. In another recent important contribution, Yu and Phillips (2001) derived the exact likelihood based on a new Gaussian discrete time form of the CKLS model to estimate the parameters. The method has the interesting property that it uses non-equispaced observations and a time-change transformation in the exact discrete model to achieve Gaussianity. Nowman's main aims in this chapter are to apply Gaussian estimation methods to different continuous time interest rate models on Japanese daily interest rate data. The interest rates used in this study are daily Japanese interest rates. The first set are daily one and three month Certificate of Deposit (CD) middle rates from the Datastream database over the period January 1993 to March 2005 giving a total of 3181 observations. The second set is Eurocurrency rates of maturities: one week and one, three, six and twelve months over the period March 1990 to July 2002 giving a total of 3228 observations. The continuous time models were explained and estimated using recently developed Gaussian estimation methods for these models. The effect of the BOJ's zero interest rate policy and quantitative monetary easing policy has had an impact on the empirical implied volatility-level elasticity found to hold in these models and the choice of yield curve models for valuation purposes for use by financial practitioners in Japanese fixed income markets in the future.

3.4. Market Integration

The **Cha, Jithendranathan and Kim** work investigates the long run comovement of the following categories of assets from Japan and the U.S.—equities, short and long-term government bonds and corporate bonds. Japan and the U.S. are the largest two economies of the world, and the equity and bond markets of these two countries are two of the largest in their respective categories. There is considerable

cross listing of Japanese equities in U.S. markets, at the same time Japanese are the largest investors in the U.S. Treasury bond market. These two factors can lead to the assumption that there must be certain degree of comovement between the asset markets of these two countries. Therefore, the main thrust of this paper is to see whether there is the long run comovement between the asset returns within the national market and across the markets of the two countries. There are a few studies on the linkages of international bond markets, while there are a fairly large number of papers on the linkages of stock markets.

The researchers as a preliminary step, test for a unit root in variables to check stationarity of the variables concerned. To test for a unit root (or the difference stationary process), we employ both the Augmented Dickey–Fuller (ADF) test (1979) and the Phillips–Perron (PP) test (1988) based on the following regressions. They further employ Park’s (1992) Canonical Cointegration Regression (CCR) method to estimate a cointegrating vector and to test cointegration between the variables in which we are interested. The data for this study include 252 monthly and 84 quarterly observations, covering a 21-year period from January 1984 to December 2004.

One of the key results of this study is the evidence of comovement between the asset returns of the two markets during the time period covered. The second key result is that the comovement of asset returns seems to be more pronounced with the quarterly data as compared to the monthly data. As in Mark (1995), a possible explanation for this result is that while monthly asset returns tend to be dominated by noise, this noise is apparently averaged out over time. Thus systematic comovements between asset returns are likely to be more predictable with longer horizon data. Overall the results of this study can be construed as indirect evidence of the effect of cross investments leading to more integration of asset markets of the two countries.

The **Jeon, Ji and Zhang** paper examines the dynamic trends of international linkages of the Japanese bond yields with bond yields in the US, the UK and Germany during the period from January 1980 to December 2004. In this paper they use monthly time series of long-term government bond yields, which are available from International Financial Statistics (IFS). The data cover the 25 year period from January 1980 to December 2004, including 300 monthly observations. They analyze both the nominal bond yields and exchange rate-adjusted bond yields by applying various short-term and long-term focused time series methodologies. Applying the vector autoregression (VAR) model and the vector error correction (VEC) model to monthly observations of nominal bond yields and exchange rate-adjusted bond yields over the 25-year period, they provide consistent empirical evidence that the Japanese bond market is independent of other major national bond markets, but it exerts some influence in determining bond

yields in the other major bond markets. However, since the early 1990, evidence shows that the independence of the Japanese bond market has increased, while its role of leadership or influence in global bond markets has been eroded significantly. The bubble economy of Japan collapsed in 1990. After the burst of the bubble, the economic growth slowed down dramatically. To find out whether the linkage between the Japanese bond yields and those of the other three countries changed after 1990, they investigate the relationship between the bond yields of the two periods separately. This paper provides evidence that Japan's position as a major international bond market seems to have declined further in the 1990s. As is found for the whole sample, the nominal bond yield of Japan is still influenced by the US, and it affects Germany and the UK before 1990. When the exchange rate effect is added into the picture, the Japanese bond yield is not affected by the bond yield of any country. But the exchange rate-adjusted bond yield in Japan still influences the bond yields of Germany, the UK and the US. The Japanese government bond yield becomes more independent when the exchange rate effect is taken into account. After the burst of the bubble in early 1990, the nominal bond yield of Japan is only related to that of the US and the exchange rate-adjusted bond yield is not related to any other markets. The influence of Japan on the other three markets is appears to have been weakened significantly for both nominal and exchange rate-adjusted bond yields since 1990.

The **Brailsford, Penm and Terrell** study is concerned with providing evidence on the linkages between the Japanese (government) bond market and international counterparts to assist in further understanding critical issues remain about how the Asian common Bond market would link with domestic markets. It is widely accepted that further work is required on establishing stability, liquidity, efficiency and confidence in local bond markets before a common market could be implemented. In order to appreciate the consequences of adopting the Yen as a form of standard currency, and specifically in relation to bond issues, assert that we need to first understand how current Japanese bonds denominated in Yen relate to other financial markets. That is, we need to first examine evidence as to where the Japanese bond market sits in relation to global bond markets before moving to an examination of the potential influence of a Yen-denominated bond market within Asia. The study employs a time-series framework to analyze the issue. The more traditional framework for examining these questions is through VAR. However VAR modeling does not explicitly detect evolutionary causal changes in the current and contemporary variable structures. It only provides the relationships detected from the lagged model structure. Further, researchers are often concerned that the coefficients of their established models may not be constant over time, but vary when the models are disturbed by changes arising from outside factors. An obvious example of this occurs in financial markets such as the

advent of various shocks and crises. This concern has motivated the development of sequential estimation algorithms that allow researchers to update subset time series models at consecutive time instants. This approach allows for the coefficients to slowly evolve, and reveal evolutionary changes in model structures. For instance, Hannan and Deistler (1988) propose a recursive estimation of an autoregressive (AR) model while Azimi-Sadjadi, Sheedvash and Trujillo (1993) suggest recursive updating procedure for the training process of a multi-layer neural network. This innovation in this study is the development of an approach that utilizes vector finite lag (VFL) models incorporating a fixed forgetting factor. Such an approach has not been previously applied primarily because the commonly used estimation algorithms for full order models are not applicable, as the structure of the lag coefficients is estimated without imposing any zero restrictions. As a result, this motivates the development of evolutionary kernel-based recursions for SVFL models which includes full-order models but as a special case. In this study we focus on the fixed forgetting factor and use the exact-windowed case. Compared to the pre-windowed case proposed in Penm, Penm and Terrell (1995), the exact-windowed case utilizes only the available observations, without any assumption on unseen observations, to estimate model coefficients. They prefer evolutionary parameter updating algorithms because they allow for updated subset time-series models at consecutive time instants, and can show evolutionary changes in model structures. The data for the analysis are sourced as the J.P. Morgan monthly bond price indices (from Datastream) over the period September 1998 through June 2005. Their findings reveal that movements in the Japanese (government) bond market exhibit instantaneous and direct causal relationships with the UK and USA (government) bond markets. Moreover, the results support the existence of current causal relationships and lagged Granger-causality from movements in the Japanese (government) bond market to each of the four other major industrialized government bond markets studied including Australia, Canada, Denmark and Germany. In summary, the findings show that the Japanese (government) bond market is an influential player on the international stage. This is an important result in the context of the proposal for an Asian bond market.

The **Nagaysu** piece empirically examines the financial market integration using stock return and bond yield data from Japan and the US. The author uses daily data in this paper for the sample period from September 3, 1986 to June 1, 2005 (4891 observations). Stock data are based on Nikkei225 and S&P500 and are obtained from Finance.Yahoo.com. Given the 13 hour difference between Tokyo and NY (summer time), no overlapping trading hours exists between the Tokyo and NY markets. In order to analyze the interaction and causality of stock returns traded in these countries, intraday stock returns, the difference between closing and opening prices on date t , are used in this paper. In addition to stock data, the

yen-dollar exchange rate and 10-year government bond yields are obtained from the Thomson DataStream database. The JGB can be classified into: (1) short-term (six-month and one-year Treasury bills), (2) medium-term (two- and five-year bonds), (3) long-term bonds (10-year bonds), (4) super long-term bonds (15-, 20-, and 30-year bonds), (5) bonds for individual investors, and (6) inflation-indexed bonds. The latter two bonds are relatively new, and since JGB market liquidity is limited with the exception of a few issues in the 5 to 10 year segment (International Monetary Fund, 2001), this paper uses the 10-year government bond yield. This paper employs the Exponential GARCH (EGARCH) developed by Nelson (1991) in order to model volatility which is one characteristic of high frequency financial data.

The work results provide a lot of evidence to support market integration between Japan and the US as well as within the domestic market. In short, while some results are sensitive to the sample period and countries under consideration, bond markets are generally closely linked with stock markets although their relationship seems somewhat weaker than stock market linkage across countries. In particular, interaction between the stock and bond markets in the US has been very high. In the case of Japan however, the JGB yield has been increasingly influential over the Nikkei225 returns only since 1998. In addition, while a unidirectional causality existed from stock to bond markets in Japan before then, the direction of this causality reversed and now runs from bond to stock markets. This result seems to reflect the increased significance of the JGB market in Japan. Finally, author suggests ways in which this research might be extended by evaluating market interaction based on the volatility criterion. Such an approach has been adopted by other researchers in a different context, but was not explored in this paper. Secondly, the same analysis could be conducted in a multivariate context. In order to ease computational difficulties, this paper analyzes individually the behaviors of stock and bond markets. Therefore, in order to capture cross-sectional information, it would be more appropriate to model all markets simultaneously.

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Macroeconomic Environmental Developments

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Chapter 2

RECENT DEVELOPMENTS IN JAPAN'S CORPORATE BOND MARKET

Peter G. Szilagyi

1. INTRODUCTION

It has been nearly two decades since the burst of the asset bubble halted Japan's economy and exposed the weaknesses of its bank-based financial system. It was never going to be easy to restore the banking sector's health, but Japanese banks struggle with bad loans and a debt overhang to this day. The country's financial sector is finally on the way to recovery. But, it has taken several rounds of reforms to get this far, and Japanese regulators still have a long way to go to make the financial system more resilient to persistent shocks.

In all their effort, policymakers gave top priority to the development of capital markets, and the corporate bond market in particular. There was certainly an acute need to do so, as the crisis had impaired the banking sector's risk tolerance, which largely crippled the intermediation of savings in the real economy. The consequences of financial liberalization have been obvious: bonds are now a more important source of funds than intermediated credit, banking ties have been loosened and corporate balance sheets largely restored. Meanwhile, the Japanese corporate market is now the second largest domestic market in the world, liquidity is soaring, and new reforms are introducing infrastructural enhancements that should further accelerate development.

This paper recounts the latest trends in Japan's corporate bond market. It also draws light on its persistent weaknesses,¹ which are continually discussed by analysts and academics alike (Schinasi and Smith, 1998; Kuratani and Endo, 2000; Hattori, Koyama and Yonetani, 2001; Rhee, 2001; Baba and Hisada, 2002; Batten

¹ To some extent, this paper is an update of Szilagyi (2005).

and Szilagyi, 2003). The market's on-going evolution conceals the fact that its contribution to efficient resource allocation continues to be limited. Only large, credit-worthy firms have turned to bond issuance, which are equally desirable bank clients but are trying to untie close banking relationships. The lower end of the market has failed to take off altogether. Non-investment-grade firms are simply priced out, often leaving them cash-strapped thus hurting the growth prospects of the Japanese economy.

The lack of development in the junk-grade segment is largely driven by the unfavourable structure of demand in the market. More than three quarters of corporate bonds are held by banks and insurance and pension funds, which typically follow a no-junk investment eligibility rule. Retail holdings remain minimal, while investment trusts have been slow to develop. These patterns are symptomatic of the extreme risk aversion of Japanese households, which continue to put the bulk of their savings into bank deposits, creating a massive excess liquidity problem in the banking sector.

A final hindrance to market development is that the Japanese market is still not strong, diverse or efficient enough to counter competition from the Euroyen market. As a result, the Euroyen market has been increasingly diverting issuance from domestic firms, and continues to undermine the *Samurai* market intended for non-resident borrowers. This is a non-trivial matter, since a pickup in Samurai issuance in particular could boost domestic issuance in the junk segment, as well as ease the liquidity trap burdening the Japan's financial system.

The remainder of the paper is as follows. Section 2 discusses Japan's financial system and its key weaknesses. Section 3 provides a brief overview of existing theory on financial systems. An analysis of Japan's corporate bond market is provided in Section 4. Section 5 allows for some concluding remarks.

2. THE ON-GOING WEAKNESSES OF JAPAN'S BANK-BASED FINANCIAL SYSTEM

Japan's bank-based financial system historically built around strong bank-firm relationships is uniformly credited as a driving force behind the country's post-war economic miracle. The theoretical literature discusses banking relationships extensively, and shows that at lower stages of economic development, a strong banking sector nurtured by regulators can have considerable benefits. Banks, as concentrated lenders and delegated monitors, help mitigate asymmetric information and ease liquidity constraints in the corporate sector. They also facilitate the intertemporal and cross-sectional smoothing of risk, acting as a kind of buffer that absorbs economic shocks (Leland and Pyle, 1977; Diamond, 1984; Boyd

and Prescott, 1986). The financial system in Japan, which also tied banks and industry together through cross-ownerships, thereby establishing large self-funding *keiretsu*, performed these tasks meticulously.

With the burst of the economic bubble in the late 1980s, the potential weaknesses of the same system were also exposed. The smooth functioning of a bank-based financial regime demands that there be no large and persistent shocks to the system and that bank management be continuously sound. In Japan, bank lending practices had become increasingly slack during the bubble period, fuelled by an unprecedented stock market run. With the burst of the stock and asset prices, Japanese banks were left with a vast portfolio of non-performing corporate and real estate loans. Bank reserves fell, the bad loan problem went from bad to worse, and between late 1994 and mid-1996 eight banks went bankrupt. The banking crisis peaked immediately after the Asian crisis in late 1997, when Japanese banks were paying up to 50 basis points, the so-called Japan premium, over the LIBOR. The government's convoy policy, which ordered strong banks to help their weaker competitors, further aggravated the problems (Bremer and Pettway, 2002). In the meantime, the crisis spilled over to the corporate sector and especially to *keiretsu* firms with close banking relationships, and ultimately caused a severe credit crunch.

Today, Japan's financial system is still in recovery. The banking sector's ability to intermediate continues to be compromised by non-performing loans and a debt overhang problem. For the bad loan burden, there has been no immediate answer other than improvements in internal control, prudent lending and the gradual unwinding of cross-ownership structures. This has been a slow and painful process finally showing some promising results. To relieve stress, Japanese regulators have given top priority to the liberalization and development of the country's capital markets and the corporate bond market in particular. Nonetheless, converting savings into investments remains a problem in the real sector, leaving many firms cash-strapped and creating excess liquidity, which continues to hurt growth prospects in the economy.

The on-going weaknesses of Japan's financial sector are nicely captured by flow of funds data provided by the Bank of Japan. Table 2.1 reports recent changes in the financial assets and liabilities of Japanese firms. Since 1997, the liabilities of the corporate sector have declined by more than 9% to ¥ 1,294.9 trillion, while debt held by Japanese firms in either loans or debt securities has fallen by more than 30% to ¥ 524.2 trillion. The reduction has been sharpest in bank loans, driven both by demand- and supply-related factors. On the demand side, firms have consistently posted net savings, decelerating business fixed investment and repaying debt. Sluggish real demand has prompted many firms to curtail spending voluntarily. However, large, credit-worthy borrowers have also been seeking cheaper

Table 2.1
Financial Assets and Liabilities of Japanese Firms (trillions of yen)

	Assets			Liabilities		
	1997	2001	2005*	1997	2001	2005*
Currency and deposits	182.2	187.0	202.5			
Loans	41.2	30.5	28.5	608.5	484.0	410.0
By private financial institutions				437.6	346.6	278.3
By public financial institutions				84.7	85.5	81.9
By the nonfinancial sector	35.6	22.7	23.3	67.2	34.2	32.4
Debt securities	22.7	40.0	42.1	147.6	119.8	114.2
Local government securities	0.4	0.9	0.8	3.9	3.4	2.8
Public corporation securities	0.8	0.6	0.9	61.4	41.0	36.8
Industrial securities	2.9	2.7	0.5	56.0	56.3	49.3
Foreign securities	0.0	0.0	0.0	16.2	8.2	12.5
Commercial paper	2.3	2.7	7.1	10.1	10.6	10.9
Shares and other equities	137.4	104.4	157.6	380.5	377.3	517.3
Foreign direct investment	25.3	22.6	15.2			
Foreign securities investment	28.1	41.0	41.4			
Other	326.3	282.4	268.2	291.5	263.8	253.3
Total	763.0	708.0	755.4	1,428.1	1,244.9	1,294.9
<i>Financial deficit</i>				-665.1	-536.9	-539.5

*2005 data as of September 30.

Source: Flow of Funds Accounts (various issues). Bank of Japan, Research and Statistics Department, <http://www.boj.or.jp/en/index.htm>.

funding in the capital markets and trying to loosen lending relationships. Banks also find it difficult to compete with public financial institutions that provide cheap funding at rates that are, in line with policy objectives, determined outside of the market mechanism.

On the supply side, on the other hand, banks continue to ration credit to less credit-worthy borrowers due to concerns that their loan portfolios will further deteriorate. For small- and medium-sized firms in particular, the reduction in borrowing largely owes to this erosion of funding conditions. Importantly, banks ration credit without having alternative profitable investment opportunities, which contributes to the severe excess liquidity problem obviously burdening in the banking sector.

The financial balance sheet of banks provided in Table 2.2 well demonstrates the excess liquidity problem, which is constantly prompting claims that the Japanese banking sector has become essentially oversized. The table shows that over the past decade, bank deposits have continued to grow as Japanese retail

Table 2.2

Financial Assets and Liabilities of Japanese Banks (trillions of yen)

	Assets			Liabilities		
	1997	2001	2005*	1997	2001	2005*
Currency and deposits	153.0	152.4	160.1	827.6	873.5	909.5
Loans	761.3	690.6	620.5	188.3	164.6	163.0
Housing loans	79.2	99.8	124.8			
Consumer credit	17.3	13.4	11.1			
To companies and governments	628.9	537.9	440.8	43.2	26.2	24.4
Debt securities	144.0	203.6	277.8	69.2	57.7	40.5
Financing bills	1.7	26.0	31.8			
Government securities and FILP bonds	56.2	82.2	133.2			
Local government securities	15.1	17.4	16.6			
Public corporation securities	11.8	12.4	18.2			
Bank debentures	17.8	15.9	11.6	68.1	45.2	26.1
Industrial securities	12.9	18.7	26.2	0.3	8.9	11.1
External securities	2.3	3.9	6.2	0.9	0.7	0.3
Commercial paper	7.4	8.4	6.0	0.0	2.9	3.0
Securities investment trusts	5.4	7.9	8.5			
Trust beneficiary rights	11.8	7.6	11.4			
Structured-financing instruments	1.6	3.2	8.1			
Mortgage securities	0.0	0.0	0			
Shares and other equities	47.5	45.9	67.0	48.4	46.4	96.5
Shares	45.6	33.1	31.5	43.9	23.6	48.9
Financial derivatives	32.6	24.5	17.3	35.3	26.7	18.1
Forward-type instruments	30.7	23.6	16.1	34.1	25.8	17.0
Option-type instruments	1.8	0.9	1.2	1.2	0.9	1.0
Foreign direct investment	6.2	10.2	17.2			
Foreign securities investment	20.6	31.9	44.9			
Other	35.0	31.1	29.1	37.3	26.9	29.8
Total	1,200.2	1,190.1	1,233.9	1,206.1	1,195.7	1,257.2
<i>Financial deficit</i>				-6.0	-5.6	-23.4

*2005 data as of September 30.

Source: Flow of Funds Accounts (various issues). Bank of Japan, Research and Statistics Department, <http://www.boj.or.jp/en/index.htm>.

investors remain distrusting of capital markets. This persistently strong preference for bank deposits is largely indicative of Japanese households' extreme risk aversion, a result of the post-bubble hangover. Figure 2.1 shows that households in Japan hold more than half their savings in deposits and another quarter in insurance and pension reserves. With vast holdings of shares, bonds and securities investment trusts, the asset portfolios of US households could not be more dif-

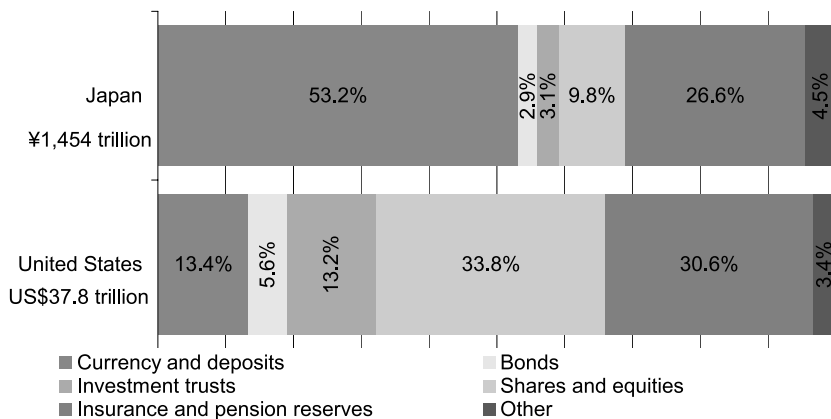


Fig. 2.1. Household Financial Assets in Japan and the United States (September 2005). Note: Households, by definition of the Bank of Japan, include business-like elements such as own-account workers. Source: Bank of Japan, Flow of Funds Accounts, <http://www.boj.or.jp/en/index.htm>; and Federal Reserve Bank, Flow of Funds Accounts of the United States, Third Quarter 2005, <http://www.federalreserve.gov/releases/z1/current/data.htm>. In: Bank of Japan (2005), Flow of Funds (3rd Quarter of 2005) — Japan and U.S. Overview.

ferent. In Japan, the popularity of deposits has been uncurbed by the negligible returns well below one tenth of a basis point. Government policy has often served to reinforce this trend by being protective of troubled banks and, just as importantly, of the postal saving system whose virtually risk-free deposits offer a highly advantageous risk-return profile.

Banks, which continue to attract deposits but remain impaired in their risk tolerance, have been channelling excess liquidity into a variety of high-quality capital market investments. Japanese Government Bonds (JGBs), admittedly issued to some extent just to mop up excess funds in the banking sector, now constitute more than 10% of bank assets in Japan despite extremely low yields. This has led to the adverse situation where banks support the government's slack fiscal policy² and buttress the persistence of the excess liquidity problem while undermining their own profitability. Banks have also stepped up investment in other high quality securities including corporate bonds. This underpins demand at least in the top end of the corporate bond market. However, banks remain reluctant to invest

² With an outstanding US\$ 6.9 trillion in government bonds, Japan's public debt was an estimated 170% of GDP in 2005, by far the highest among the G7 countries. Much of this debt is a result of intra-governmental lending, however, thus the government owes only US\$ 1.5 trillion to external parties. Nonetheless, the budget deficit reached around 7% in 2005 and is expected to remain at around 5–10% of GDP in the near to medium term.

in riskier bonds, which impedes greater risk sharing in the capital markets and ultimately does little to encourage risk-taking in the Japanese economy.

3. THE THEORY OF THE FINANCIAL SYSTEM

The need to encourage financial risk-taking in Japan by way of developing capital markets is well recognized by regulators, and corresponds to the ever-expanding theoretical literature on comparative financial systems. Levine (2000) identifies four competing views of financial structure, and emphasize that all four boost their own merits. The *bank-based view* (Boot and Thakor, 2000; Rajan, 1999) advocates the role of banks within the financial system. The *market-based view* (Hellwig, 1991; Rajan, 1992) regards markets as being more appropriate in achieving capital allocation efficiency. The *law and finance view* (Benston and Smith, 1976; La Porta et al., 2000) primarily emphasizes the role of the legal system in generating financial development. Finally, the *financial services view* (Levine, 1997; Allen and Santomero, 2001; Boyd and Smith, 1998) considers the provision of financial services as the most important issue within the financial system.

It is the financial services view that stresses that banks and markets may act as complements in providing financial services and reducing information and transaction costs. Bolton and Freixas (2000) propose a model of segmented markets, where in equilibrium riskier firms prefer bank loans, the safer ones tap the bond market, and the ones in-between prefer to issue both equity and bonds. This segmentation of financing is somewhat consistent with the stylized facts seen in developed financial markets. Nonetheless, banks and bond markets remain imperfect substitutes even under general conditions. For large companies, the financing of high-risk projects continues to require the involvement of banks, which therefore retain a central function. This is consistent with Ongena and Smith's (2000) investigation of multiple-bank relationships, which shows that firms maintain banking relationships even in countries with unconcentrated but stable banking systems and active corporate bond markets.

These and other academic studies prompt the conclusion that banks and capital markets may coexist efficiently. Efficient capital markets can have substantial benefits in otherwise bank-based systems as well, notwithstanding the past success of the bank-oriented regimes of Germany and Japan. The literature recounts a wide range of these benefits. Takagi (2002) advocates the ability to reduce funding costs by forcing the banking sector into competition; improved resource allocation through the provision of market price signals; more efficient corporate capital structures and external market discipline that help manage agency costs; and better encouragement for the financing of innovation. Dinc (2000) shows that

competition induces banks to lend to lower quality borrowers they would otherwise refuse. Weinstein and Yafeh (1998) emphasize the lower dependence of firms on banking relationships, while Sharma (2001) mentions the possible reduction of maturity mismatches, arising when firms borrow short term to finance long-term projects. Finally, for Japan, Batten and Szilagyi (2003) and Szilagyi (2005) argue that more developed capital markets should help mitigate excess liquidity in the banking sector. At the same time, better market mechanisms should aid risk sharing in the financial system, improving its ability to withstand prolonged volatility shocks.

Those who advocate the transition from a bank-based to a more market-based financial system, stress that financial reform is only a first step in laying the foundation for better economic growth. Smith's (1995) survey of corporate bond markets provides a comprehensive overview of the reasons why bond markets can remain underdeveloped in developed economies, as well as tackle the consequences of shifting corporate borrowing towards market-based sources. Other authors, including Batten and Kim (2001), Sharma (2001) and Cheung and Chan (2002) provide a reform agenda for Asia-Pacific economies in the post-crisis period. They agree that the building of bond markets demands a strong legal and regulatory framework, improved investor protection, better information disclosure and the promotion of best practices. The appropriate sequence of infrastructure development is equally important, and includes the development of products and the investor base to ensure liquidity, the improvement of the regulatory framework for valuation, accounting and disclosure, and the implementation of risk management and settlement capability. Finally, Beck, Levine and Loayza (2000) argue that for the overhaul of the financial system to be successful, property rights and bankruptcy laws must be enforced, tax systems revised and state-owned enterprise privatized. This is a key issue for Japan, which has implemented a plethora of reforms in the past two decades, but must still tackle a broad agenda of which financial market reform is but a part.

4. RECENT TRENDS IN JAPAN'S CORPORATE BOND MARKET

Until the 1980s, the corporate bond market in Japan was highly regulated, immature and segmented along banking relationships. For issuers, strict eligibility prevailed based on credit ratings, and caps were kept in place on the amount that could be issued. In addition, issuance terms were set by the bond underwriting cartel, the *kisaikai*, which gave banks a strong bargaining position and kept issuance costs high. Eligibility guidelines and control by the *kisaikai* over the issu-

ing process were not relaxed until the late 1980s, when the revision of the Foreign Exchange Control Law triggered a huge flight of borrowers from the domestic to the Euroyen and other Eurobond markets in search for lower costs, less regulation and greater flexibility. At the same time, previously stringent equity market regulations were also relaxed, resulting in a substantial shift from debt to equity finance. The liberalization wave of this period is discussed in detail by Kester (1991), Hoshi, Kashyap and Scharfstein (1993), Weinstein and Yafeh (1998) and Yasuda (2001).

The burst of the bubble economy and the prolonged ailing of the banking sector instigated regulators to introduce a second round of reforms in the 1990s. The strengthening of capital markets and the activation of capital market transactions demanded extensive reforms in the corporate bond market. The "Big Bang" initiative of 1996 eliminated eligibility standards, deregulated trustee, underwriting and brokerage fees,³ liberalized the derivatives market, abolished the securities transaction tax and made withholding tax exemptions, and improved conditions for exchange and over-the-counter (OTC) trading. To build up an investor base, the reform also introduced the OTC sales of investment trusts, reformed the pension system and approved entry by banks, securities firms and insurance companies into each other's business. The consolidation of the credit ratings system also took place in this period, lending greater credibility to ratings agencies of which two domestic and three international remain.⁴

Today, the reform process continues, continually upgrading market conditions. In August 2002, Japan's Financial Services Agency adopted a comprehensive program for promoting securities markets reform, focusing on three broad areas: establishing an efficient and competitive market; creating a fair and transparent market; and providing easy access to everyone. The full dematerialization of corporate bonds was legally inducted in 2003, and the corresponding book-entry system, operated by the Japan Securities Depository Center (JASDEC), began operations in January 2006. The Bank of Japan simultaneously introduced real-time delivery-versus-payment (DVP) via the BOJ-NET Funds Transfer System, and began accepting dematerialized corporate bonds as eligible collateral for its various credit operations. These developments should greatly enhance the safety and efficiency of settlement, and are expected to reduce issuance and transaction costs. At the same time, steps have been taken to improve corporate governance and implement internationally consistent accounting and auditing standards, enhance

³ De Jong, Roosenboom and Schramade (2005) report that underwriting fees dropped substantially for firms not belonging to *keiretsu* between 1994 and 2002.

⁴ The five designated ratings agencies are Rating and Investment Information, the Japan Credit Rating Agency and the three top international agencies, Moody's, Standard and Poor's and Fitch Ratings.

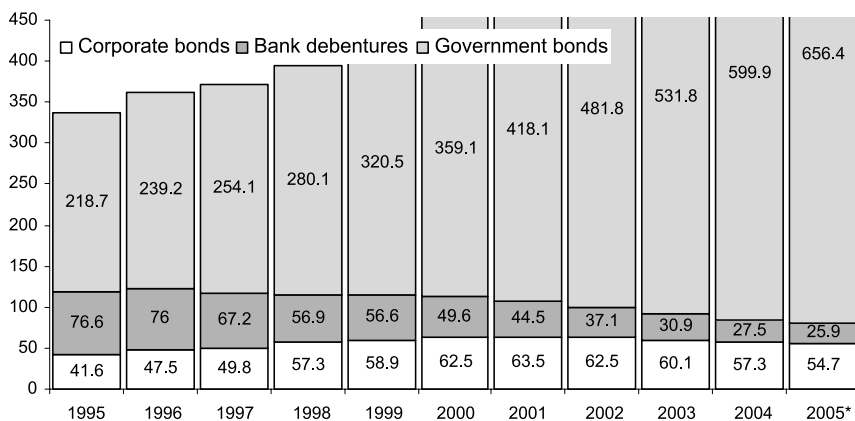


Fig. 2.2. Outstanding Yen-Denominated Bonds in Japan (trillions of yen). Note: 2005 data as of November 30. Source: Japan Securities Dealers Association, www.jsda.or.jp.

auditor oversight and independence, strengthen the rules applicable to securities analysts, as well as promote the development of securities exchanges.

The reform effort has also been assisted by globalization and advances in information technology (IT) over the past decade. The three factors have worked together to assist the on-going evolution of the corporate bond market shifting the balance of between the banking sector and capital markets towards the latter. Baba and Hisada (2002) describe how IT innovation and financial engineering have facilitated the quantitative assessment of risk-return profiles, fostered securitization techniques and encouraged arbitrage trading. IT development has also eroded the banking sector's comparative advantage in information production, forcing banks to pursue more objective profitability measures and diversify more into investment banking. Meanwhile, globalization has increased the substitutability of domestic and foreign financial assets, and is hoped to boost the participation of foreign investors.

The key hindrances to development in Japan's corporate bond market ultimately come down to supply and demand, however. Figure 2.2 shows that bond issuance has failed to produce a major take-off since the East Asian crisis despite the ensuing credit crunch that crippled the risk tolerance of the banking sector. The Japanese market remains barely one fifth the size of the US market, with the value of outstanding issues declining from a high of ¥ 63.5 trillion in 2001 to ¥ 54.7 trillion in November 2005. Issuance remains largely limited to specific sectors such as electricity, land transport and transport equipment, wholesale, re-

tail and telecommunications. It is also highly concentrated, with the top 3 issuers accounting for over one third of market value.

Given the enormous excess liquidity problem burdening Japan's financial system, concerns that the on-going expansion of the JGB market may be crowding out corporate securities appear unwarranted. Rather, growth has been depressed by sluggish demand for funds, which limits borrower competition to offer potentially liquid securities. The market has been hurt by a drop in issuance by utilities firms such as electricity suppliers, which have reduced interest-bearing debt by lowering capital investment. Equally detrimental has been the fact that borrowers have been increasingly taking issuance abroad, to the Euroyen market, in search of better conditions despite higher yields.

On the demand side, broader development of the market is hindered by the fact that less credit-worthy issuers are automatically priced out. Standard and Poor's (2005) points out that only 6% of outstanding bonds carry a non-investment-grade credit rating of BB+ or less, and the vast majority of these had been investment-grade at issue. In comparison, junk bonds in the US constitute 37% of the market and are worth around US\$ 1 trillion. The low demand for junk bonds by institutional investors is largely driven by internal investment eligibility rules rather than a quantitative risk-return assessment. Notably, many pension funds follow the guidelines set by the Government Pension Investment Fund, which prohibit investment in junk bonds and command the sell-off of investment-grade bonds downgraded to junk.

The historical reluctance of Japanese investors to quantitatively compare risk and return is illustrated by the huge spreads still demanded on junk bonds. Standard and Poor's reports that the average spread of BB+-rated corporate bonds over JGBs is 237 basis points, while the one-year probability of default for the same securities is only 56 basis points. Conversely, the investment-grade end of the market has become increasingly tight in recent years. Since 2003, spreads have fallen sharply on BBB-rated bonds as well, and as of late 2005, they were below 50 basis points for 99% of the market (see Figure 2.3). The extent of tightening is nicely demonstrated by the fact that in the US, similar spread is demanded from AAA-rated issuers, further underlining the demand-related problems in the Japanese market.

Indeed, the improvement of spreads in the investment-grade segment is largely attributable to demand-related pressure. The market quickly recovered from the blow dealt by the last high-profile default in September 2001, of retail conglomerate Mycal, and the subsequent accounting scandals in the US. Excess liquidity and low JGB yields are prompting institutional investors to enter into aggressive credit risk purchases on the safe side of the market. Risk pricing has been relaxed by the extreme rarity of defaults, as well as the appreciable performance of asset

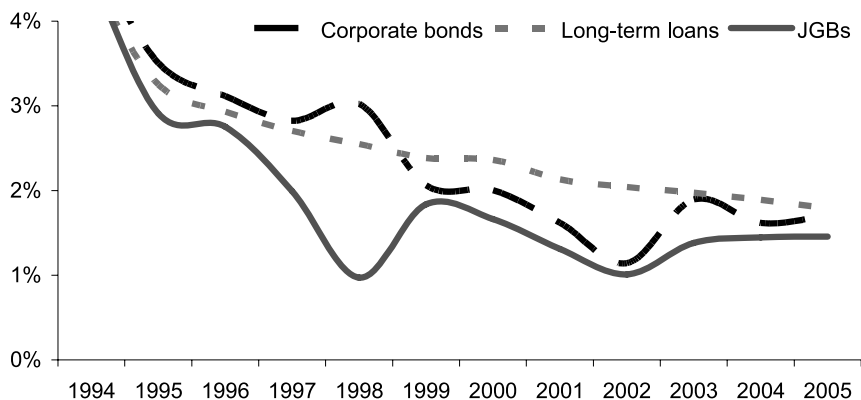


Fig. 2.3. Bond Yields and Loan Interests in Japan. Source: Bank of Japan, Financial and Economic Statistics Monthly, January 2006, <http://www.boj.or.jp/en/index.htm>.

managers who have prioritized larger yields over credit risks. Crucially, corporate profits have also recovered to levels last seen in the late 1980s, accompanied by a considerable improvement in capital positions. The latter half of 2005 saw a slight reversal in credit spread tightening, as firms increased capital expenditure and stepped up dividend payments and share buybacks. Nonetheless, spreads remain at historically low levels, a trend that is likely continue despite signs that the Bank of Japan may finally begin to tighten its ultraeasy monetary policy.

The source of demand-related hindrances to market development is the very structure of demand, which is illustrated in Figure 2.4. More than three quarters of corporate bonds are held by banks (40%) and insurance and pension funds (35.6%), which largely follow the no-junk internal investment policy. Securities investment trusts have been slow to develop, due to the risk intolerance of retail investors. They could nonetheless underpin demand for lower-rated securities but instead seek higher returns abroad. Finally, households themselves stepped up purchases somewhat in the late 1990s but have been discouraged from investing in the market by a series of downgrades in recent years.

The limited appetite of Japanese investors for evaluating and trading in credit risk is intensified by the fact that foreign investors are increasingly uncomfortable holding large positions in Japanese debt. Since 1997, non-resident holdings of corporate bonds fell from 3.8% to just 0.3%. Foreign investors are alarmed in particular by a potential increase in yields, associated with the on-going growth of the JGB market and a sentiment of increasing oversupply. Standard and Poor's

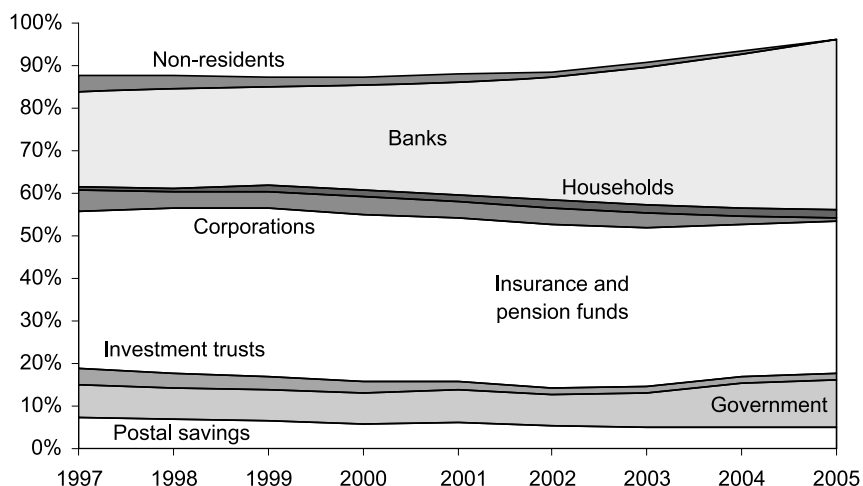


Fig. 2.4. Corporate Bondholders in Japan. 2005 data as of September 30. Source: Bank of Japan, Flow of Funds Accounts and Banking Accounts of Domestically Licensed Banks (various issues), <http://www.boj.or.jp/en/index.htm>.

have voiced similar concerns, and between February 2001 and April 2002 downgraded Japan's sovereign credit rating by three notches, from AAA to AA—.

The failure of the market to meet high-end demand, evidenced by the immense tightening of credit spreads, is exacerbated by its struggle against the highly competitive Euroyen market. In sharp contrast to the decline in issuance domestically, Euroyen issuance by credit-worthy Japanese firms continues to climb and now constitutes around 30% of new issues compared to 4.2% in 1998 (see Table 2.3). For Japanese borrowers, part of the appeal of the Euroyen market is the chance to diversify their investor bases. Many firms have also historically preferred issuing Euroyen securities due to withholding tax and custodial problems. The infrastructure available in London and Luxembourg is another attraction luring borrowers. The centralized depositories Euroclear and Clearstream provide seamless services in clearing and settlement, and the Japanese market has been unable to match these.

The competitive advantage of the Euroyen market also undermines the ability of the *Samurai* market, Japan's yen bond market for non-residents, to attract foreign borrowers with yen needs. Table 2.3 shows that Samurai issuance remains barely a fifth of Euroyen issuance by overseas entities. This is hardly surprising, as significant differences remain between the two markets in terms of both cost and time length required for issuance. In the Samurai market, some proce-

Table 2.3

Issuance in the Euroyen and Samurai Markets (billions of yen)

	Japanese international issuance and foreign currency domestic issuance			Non-Japanese issuance in Japan			
	Of which:			Of which:			Euroyen bonds by non-Japanese
	Total	Foreign-currency	Euroyen	Total	Foreign-and dual-currency	Yen	
1992	6,526.8	6,520.8	3,006.0	1,175.1	0	1,175.1	3,328.0
1993	6,204.4	3,921.9	2,282.5	1,693.4	35.0	1,658.4	5,102.1
1994	2,590.4	1,898.7	691.7	1,230.7	100.3	1,130.4	10,194.2
1995	1,953.2	1,541.9	411.3	1,616.5	640.0	976.5	10,884.5
1996	2,968.6	2,013.0	955.6	3,933.7	2,612.5	1,321.2	12,909.9
1997	2,770.8	1,843.9	926.9	2,176.2	1,456.0	720.2	17,872.6
1998	1,362.4	796.2	566.2	412.3	152.5	259.8	12,328.6
1999	2,892.2	1,462.6	1,429.6	1,036.8	14.5	1,022.3	13,918.2
2000	1,944.2	683.8	1,260.4	2,919.0	62.3	2,856.7	16,771.9
2001	2,392.5	861.0	1,531.5	2,019.0	318.5	1,700.5	17,256.7
2002	2,490.9	450.3	2,040.5	2,118.7	820.5	1,298.2	12,322.3
2003	3,332.4	613.8	2,718.6	2,391.8	970.8	1,421.0	11,085.7
2004	4,111.8	982.6	3,129.2	2,774.3	927.3	1,847.0	8,881.7
2005*	3,365.1	1,770.3	1,594.7	3,071.0	1,160.9	1,910.1	10,664.5

*2005 data as of November 30.

Source: Japanese Ministry of Finance, <http://www.mof.go.jp/english/e1c009.htm>.

dural problems also persist such as the need to prepare the relevant documents in Japanese. These are non-trivial matters from the viewpoint of Japanese policymakers, as a pickup in Samurai issuance could help ease the liquidity trap burdening the country's financial system, as well as have a positive spillover effect on the entire Japanese debt market. The Samurai market could strongly contribute to the low-end segment of the market in particular, as it hosts regular issues by emerging market sovereigns such as the Philippines. Indeed, Samurai investors are becoming increasingly receptive of not only top-rated corporate issuers, but less credit-worthy corporate and semi-government borrowers from emerging markets. As such, the Samurai market appears to relax the risk intolerance of Japanese investors, because the unfamiliarity of many borrowers demands a more thorough and objective risk evaluation. It is welcome news that after Argentina's default on its Samurai bonds in 2001, investor appetite picked up relatively quickly for these securities. Nonetheless, the Samurai market remains in desperate need of a boost, which calls for further concerted efforts to increase its competitiveness by all means possible.

On the whole, however, the recent reform process in Japan's corporate bond market must be given a fair bit of credit. A barometer of success has been the rapid rise in liquidity. Between 1998 and 2005, over-the counter trading in Tokyo quadrupled to ¥ 80.5 trillion, despite a notable decline in the size of the market. Liquidity helps mitigate investor concerns over market risk and should encourage the acceptance of credit risk. The on-going dematerialization of corporate bonds and the Bank of Japan's introduction of DVP can only accelerate this trend. Ultimately, the processes at work envisages a large and liquid market in all credit risk segments that can greatly improve resource allocation in the real sector, fostering innovation, and making Japan's financial system more resilient to future shocks.

5. CONCLUDING REMARKS AND FUTURE DIRECTION

The collapse of Japan's bubble economy severely compromised the banking sector's ability to intermediate, and is largely blamed for the country's prolonged economic stagnation. The banking crisis has caused persistent financing problems for Japanese firms, while trapping excess liquidity in the financial system. For the bad loan burden confronting Japanese banks, there has been no immediate answer other than improvements in internal control mechanisms and the eventual dismantling of the cross-ownership structures with industry. This however has been a lengthy process, while reduced risk tolerance in the financial system has been a hindrance to Japan's economic recovery. This paper has shown that the corporate bond market should provide a key contribution to encouraging risk-taking, but largely fails to do so by lagging behind in terms of development, efficiency and diversity.

For the market mechanisms to work more efficiently, further improvement in Japan's financial infrastructure is necessary in the broadest sense of the word. The key areas where development is indispensable have been extensively discussed by in the prior literature. In recent years, significant inroads have been made. In August 2002, Japan's Financial Services Agency adopted a comprehensive program for promoting securities markets reform, which focuses on the establishment of a fair, efficient, competitive and transparent market. A number of fresh reforms have already been introduced, including the dematerialization of corporate bonds and the adoption of DVP. Steps have also been taken to improve corporate governance and accounting standards, strengthen the rules applicable to securities analysts and promote the development of securities exchanges.

It is evident that there remains room for further development in practically all areas. Necessary infrastructural enhancements include even greater market liquidity, the reduction of price distortions, better disclosure and the strengthening

of market surveillance. There is room for improvement in corporate governance, and the market for corporate control should be activated. More generally, it is imperative that a diverse and multilevel investor base be developed with the assistance of both lawmakers and regulators. The internationalization of market participants is all but a key element of this strategy, which demands the improved competitiveness of the Japanese market in the global setting.

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Chapter 3

THE PAST, PRESENT AND FUTURE OF THE SECURITIZATION MARKET IN JAPAN

Roanne Coman

Abstract

This paper paints the “big picture” of the securitization market in Japan. It shows the problems in the financial system that led to the creation of the market. It investigates the legislation enacted for perfecting loan assignments, special purpose vehicles, loan servicing and other measures that were introduced to create the market and the subsequent changes made to the legislation in order to improve growth. It also shows the current trends and possibilities for the future of the market and the role that the market is playing in improving the health of financial institutions and the overall Japanese economy.

INTRODUCTION

When looked at from the outside, many people view Japan as a country that is mysterious and intriguing. However, from the inside Japan is no different to any other country. Like all countries its history contains successes and mistakes to be learned from and through these valuable lessons, it has created a culture that has been passed on and improved by each generation. All human beings have strengths and weaknesses and because each country has its own unique culture that has evolved through generations of human thought, each country has a unique set of strengths and weaknesses. These strengths and weaknesses make each country a great learner from and a great teacher to other countries.

Being one of the world's largest economies, the financial system in Japan attracts attention from the media and interest from researchers. However, in recent years, it has attracted the most attention for its weaknesses, rather than its

strengths. The period since the bubble burst is referred to in Japanese as “*ushinawareta juunen*” or “the 10 years lost”, but many of the problems left in the bubble’s wake, such as non-performing loans and deflation, are problems that many economies have faced at one point or another over time. Hence, this period has created a great learning opportunity, not only for Japan, but also for scholars and financial specialists around the world.

Traditionally, Japan has been a country of indirect financing through banks, but the massive non-performing loans and *kashishiburi* (reluctance of banks to lend money) problems, that have crippled the financial system and economy in general since the bubble economy burst, have pushed Japan more towards direct financing sources, especially securitization. Securitization, which is a financing technique based on the risks and returns associated with assets, allows financial institutions and companies with poor credit ratings to effectively access funds in capital markets.

The aim of this paper is to paint the “big picture” of the securitization market in Japan.¹ It will outline the legislation enacted to create the market, how the market has subsequently developed and where it is headed in the future. It will also highlight the problems experienced in establishing the market, issues to be solved for its future development, the cultural background and distinctive characteristics of the market and the role that the market is playing in improving the health of financial institutions and the overall Japanese economy.

1. WHAT IS SECURITIZATION?

In its simplest form, securitization is a financing technique where funds are raised based on the cash flows and risks associated with a specific asset or pool of assets. The assets are isolated by transferring them to a bankruptcy remote special purpose vehicle (SPV) that issues securities backed by claims to the assets’ cash flows. The funds raised from issuing the securities are paid to the transferor, or “originator”, of the assets and the cash flows realized from the assets are regularly paid to the investors, who are also exposed to the risks associated with the assets.

As shown in Figure 3.1, with advances in financial technology, the SPV has turned into a financial factory, which processes the cash flows and risks associated with the assets into several classes, or “tranches”, of securities that have different risk-return profiles. This is accomplished by the use of credit support and prioritization of payments to the different tranches; cash flows flow down the

¹ This article does not cover different forms of securitization of real estate, such as real estate investment trusts (REIT), which are also gaining popularity in Japan.

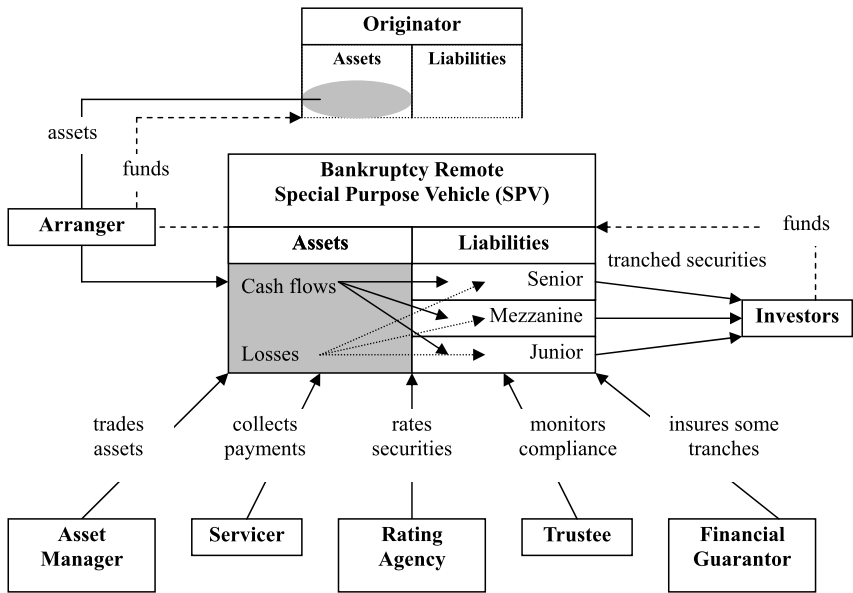


Fig. 3.1. Basic Structure (based on Working Group of the Committee on the Global Financial System, 2005, p. 6).

tranches from the most senior tranche and losses flow up the tranches from the most junior tranche. The aim of this tranching process is to create at least one class of securities whose rating is higher than the underlying assets or to create some rated securities from unrated assets. This form of securitization is referred to as structured finance (Working Group of the Committee on the Global Financial System, 2005, p. 4).

In Japan, while the term structured finance is used in the same manner as the English expression, there are two expressions for securitization: “*shoukenka*” (literally “securitization”) and “*ryuudouka*” (literally “liquidization”). As shown in Figure 3.2, *shoukenka* broadly refers to the shift from indirect financing to direct financing by issuing securities and *ryuudouka* refers to the process of turning illiquid assets into liquid assets. The English concept of “securitization” falls within both these expressions and can be distinguished from the above expressions by the addition of the term *shisan* (asset) (Kinoshita, 2004, p. 21).

A key aspect in securitization, is the legal isolation, or “de-linking”, of the assets from the originator and other parties through a bankruptcy remote SPV. This includes legally assigning the rights associated with the assets to the SPV and,

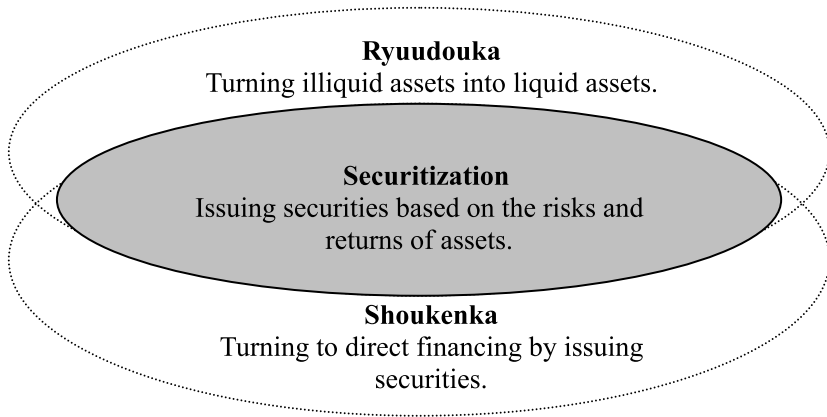


Fig. 3.2. Securitization, Shoukenka & Ryuudouka (based on Kinoshita, 2004, p. 21).

by placing the SPV's capital into a charitable trust and restricting its activities, minimizing the possibility that the SPV will go bankrupt or be liquidated.

As the SPV is a separate legal identity, there are legal and taxation requirements that can make some legal structures prohibitively expensive. Some countries have legal systems that are securitization friendly and other countries, including Japan, which make securitization prohibitive. In the latter case, this can lead to securitizations being undertaken offshore in a more securitization friendly jurisdiction, such as the Cayman Islands.

Hence, it is no surprise that the first Japanese securitizations were undertaken offshore. However, such offshore securitizations took considerable time and resources to launch and in order to make such transactions profitable, a certain amount of standardization is required. In contract-oriented countries, which tend to value originality and flexibility, such standardization would be achieved through the creation of standardized terminology in contracts. However, in countries which value the stability associated with uniformity, such standardization is achieved through the creation of domestic laws, which may limit creativity and flexibility (Frankel, 2001, p. 15), but at the same time also create a lot of political involvement in market creation.

As shown in Figure 3.3, Japan falls into the later category with the forerunner to securitization legislation being enacted in 1992 to allow credit and lease companies better access to capital markets following the credit crunch that they experienced upon the bursting of the bubble economy. Further legislation was enacted for perfecting loan assignments, SPV and servicers as part of the big bang reforms in the late 1990s, when Japan decided to follow the U.S. example of us-

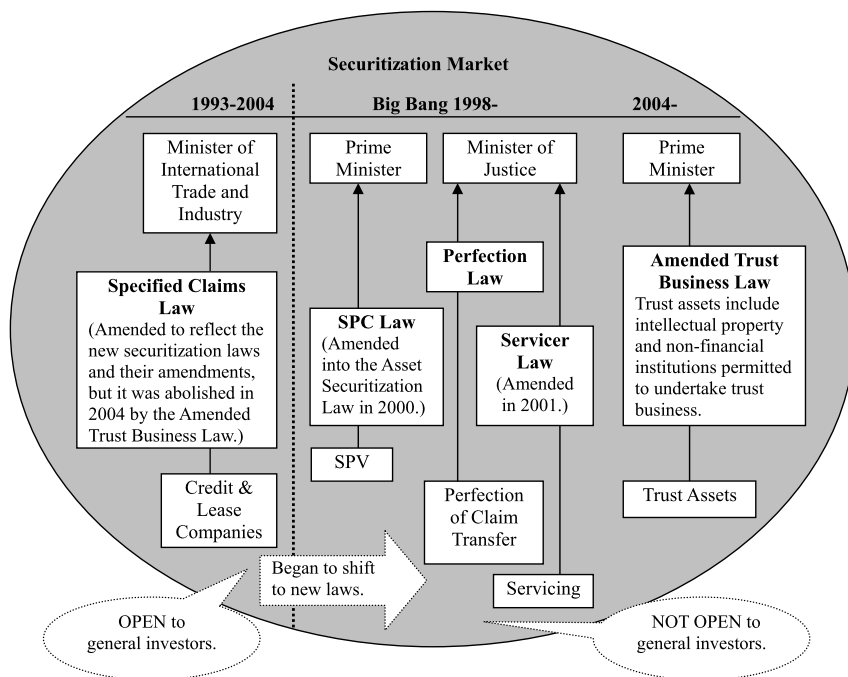


Fig. 3.3. Overview of Securitization Legislation.

ing securitization as a technique to deal with the non-performing loans left in the bubble's wake. However, as these laws were more complicated than offshore legislation, there was some resistance to their use leading to subsequent amendments several years after enactment. More recently, the Trust Business Law has also been amended to further expand the assets that can be securitized.

However, some inconsistencies exist between the laws not only stemming from the fact that they were enacted to deal with specific problems in the financial system at the time, but also from the Japanese vertical administrative system (*tatewari gyousei*). Under this highly territorial system orders cascade down like a powerful waterfall from ministries to those organizations and people under their jurisdiction. The power struggles that frequently accompany politics and administration, means there is strong resistance from ministries to having items under their jurisdiction removed or altered by other ministries. As shown in Figure 3.3, securitization laws are not under the jurisdiction of one, but several different ministers and ministries.

On top of this, a strong feature of laws and regulations in Japan is that they are enacted with a specific aim in mind, but there will always be many intricate details which can make them unnecessarily complicated and prevent their full utilization. While many foreigners often complain that Japanese systems are difficult to use, they frequently overlook the fact that such sentiments are also shared by many Japanese people who often also complain that there are many “unusable systems (*tsukaenai seido*)” in Japan.

2. CREATION OF THE SECURITIZATION MARKET

2.1. Stage 1: Specified Claims Law

In March 1990 in order to restrain the bubble economy, the government decided to regulate lending to real estate, construction and non-banking industries. However, this move left lease and credit enterprises, who were heavily reliant on bank financing, but who were basically prohibited from issuing bonds and commercial paper, strapped for funds. In 1992, with securitization in mind the Ministry of International Trade and Industry (MITI),² responsible for overseeing non-banks, created the “Law Concerning the Regulation of Business Related to Specified Claims (Specified Claims Law)” which became effective from June 1993 (Kinoshita, 2004, p. 116; 2005, pp. 3–4).

Prior to this legislation, the assignment of designated claims, including credit claims and leases, was governed by Article 467 of the Civil Code, which requires the transferor to notify or obtain consent from the obligor in writing with a certified date (*kakutei hizuke*) in order to perfect the assignment of the claims against the obligor (*saimusha taikou youken*) and third parties (*daisansha taikou youken*). This is a burdensome requirement given the associated costs and the relationship-oriented business practices prevalent in Japan.

The Specified Claims Law, outlined in Figure 3.4, was epochal in allowing the perfection of the assignment of lease and credit claims by public announcement. However, it was a very complicated law that was intently debated by the Diet and reflects the strong social opinions at the time of enactment that lease and credit enterprises must take responsibility for their role in creating the bubble economy (Kinoshita, 2004, p. 116; 2005, p. 4). Along with government ordinances, ministerial orders and notices, the law contained many requirements, including the periodic submission of a securitization plan for approval and permit and minimal capital requirements for the SPV and companies selling securitized interests.

² MITI was reorganized into the Ministry of Economy, Trade and Industry (METI) in 2001.

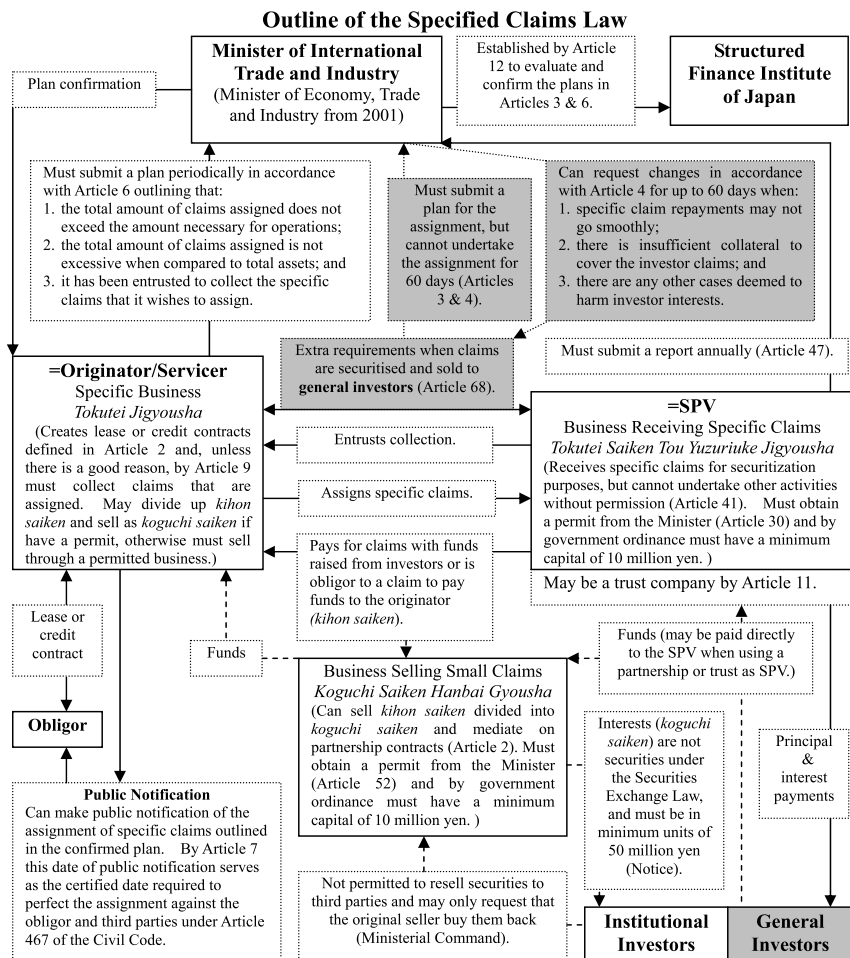


Fig. 3.4. Outline of the Specified Claims Law.

General investors were protected by the submission of an assignment plan (highlighted in gray in Figure 3.4) and requests were made within 60 days for alteration when there was a chance that payments would not be made smoothly or there was insufficient capital to cover the interests of investors. The Structured Finance Institute of Japan evaluated these plans and those outlined in the previous paragraph, having been established for this purpose in 1993.

While it was possible to sell securitized interests, referred to as *koguchi saiken*, to general investors, the interests sold were subject to heavy restrictions which effectively blocked general investor participation in the market; the interests were not securities under the Securities Exchange Act, they had to be sold in a minimum of 50 million yen units and resale was prohibited. In April 1996, legal changes were made to allow for asset backed securities (ABS) and asset backed commercial paper (ABCP) to be issued within Japan that were deemed to be securities under the Securities Exchange Law (Nihon Saiken Shinyou Ginkou, 1999, p. 35; Kinoshita, 2004, p. 119).

This led to four different styles of securitization being arranged under this Law: ABS and ABCP; the assignment method (*jouto houshiki*), where assigned claims were turned into *koguchi saiken* sold by a permitted dealer; the trust method (*shintaku houshiki*), where a trust was used as the SPV; and the partnership method (*kumiai houshiki*) where the SPV was a partnership formed under the Commercial Code (*tokumei kumiai*) or the Civil Code (*nin'i kumiai*) (Kinoshita, 2004, pp. 38–41).

Between 1993 and the end of March 2004, a total of 28 trillion yen of funds were raised through schemes arranged under this Law. At its peak in 1994, such funds made up more than 55% of total securitized instruments and while there were some schemes involving general investors, the majority of funds were raised from institutional investors. However, with the new securitization laws enacted as part of the big bang reforms, more and more schemes began to be arranged under the new laws and by the end of March 2004 funds raised under this Law had declined to a mere 16.5% of total securitized instruments (Kinoshita, 2005, p. 7).

The Specified Claims Law was abolished in December 2004 when the Amended Trust Business Law took effect, ending an important and distinctive era in securitization and effectively shutting general investors out of the market.

2.2. Stage 2: Big Bang Legislation

Following the bursting of the bubble economy in 1991, the financial system became crippled by non-performing loans that stemmed from over zealous lending practices during the bubble era. By the mid-1990s, Japan had started to experience failures of financial institutions, which is something that the Japanese financial system had been successful in preventing until then through its convoy system (*gosousendan houshiki*), where strong banks would support weaker banks to prevent bankruptcies from surfacing.³

³ For a more detailed description of this period in English, refer to Hayes (2000) and Nakaso (2001).

By the mid-1990s the problem was worsening and serious measures were required to deal with the problems inherent in the system as non-performing loans kept piling up and banks became more and more reluctant to lend money; a problem referred to in Japanese as “*kashishiburi*”. It was also apparent that Japan was declining rapidly in importance as an international financial center. This led to the big bang reforms introduced by Prime Minister Hashimoto in 1996 to make the Japanese financial market “free, fair and global” by 2001. The creation of a securitization market to revitalize the real estate market and dispose of non-performing loans was one of the aims of these reforms and included the enactment of three pieces of legislation for perfecting loan assignments, SPV and servicing.

2.2.1. Perfection Law The “Law Concerning Special Exceptions to the Civil Code Regarding the Perfection of Assignment of Claims (Perfection Law)” was enacted in June 1998 to provide an exception to Article 467 of the Civil Code for originators not subject to the Specified Claims Law. Article 4 of this Law allows originators to meet the requirements to perfect the assignment of claims against third parties by registering them at the Legal Affairs Bureau. However, in order to perfect the assignment of the claims against the obligor, it is necessary to obtain the consent of the obligor or to notify the obligor by delivering a certificate issued by the Legal Affairs Bureau. Hence, these requirements are stricter than under the Specified Claims Law and do not meet the needs of market participants.

As the requirements are costly and cumbersome for originators to meet, in practice the assignment of claims is perfected only against third parties. Paragraph 246 of the “Practical Guidance Concerning Accounting for Financial Instruments”, issued by the Japanese Institute of Certified Public Accountants (JICPA) in 2000, makes an exception for this Law by allowing claims that have been perfected in this manner to be removed from the originator’s balance sheet.

2.2.2. SPC Law and Asset Securitization Law Selection of a legal entity to act as the SPV is a very important aspect in securitization. In Japan, the options for legal entities that could be used for SPV were limited to stock companies (*kabushiki kaisha*) established under the Commercial Code, limited liability companies (*yugen kaisha*) established under the Limited Liability Company Law and trusts. While trusts formed under Japanese law fulfill the requirements for bankruptcy remoteness and have been a popular choice for the SPV, the former two legal entities contain many legal and tax related hindrances rendering them inappropriate as the SPV (Fitch Ratings, 2000, pp. 2–3).

To cope with this problem, “The Law Concerning Securitization of Specific Assets by Special Purpose Companies (SPC Law)” was enacted in June 1998 and became effective from September of the same year. As shown in Figure 3.5, under

this Law it was possible to establish a special purpose company (*tokutei mokuteki kaisha*, referred to as “TMK”) with a minimum capital of 3 million yen (equivalent to the minimum capital of a limited liability company), one director and preferential tax treatment at the SPV level. While it was possible for the TMK to issue ABS, ABCP and preferred equity, the Law contained numerous requirements and restrictions including: registration with the Financial Reconstruction Commission; registration of a highly detailed asset securitization plan (*shisan ryuudouka keikaku*) which formed part of the articles of incorporation and was very difficult to alter for investor protection reasons; restrictions on borrowing; and the assets that could be transferred to the TMK were limited to real estate, designated claims and their trust certificates.

The Law also contained some bankruptcy remoteness provisions, such as limiting the activities of the TMK to those outlined in the asset securitization plan and not allowing the board of directors to contain officers of the originator. However, the bankruptcy remoteness of the TMK was weakened by a clause allowing the preferred equity holders a right, which could not be overridden by the inclusion of provisions in the articles of incorporation, to remove a director and elect a replacement. Therefore, further structuring requirements were required in order to make the TMK effectively bankruptcy remote (Fitch Ratings, 2000, p. 3).

Under the Trust Law in Japan it is also not possible to create a charitable trust, where through a declaration of trust, the trustee can also act as a consigner of the trust assets. Hence, as shown in Figure 3.5, even if a TMK was selected to act as the SPV, it was necessary to also establish an SPV in the Cayman Islands, whose capital was then placed into a charitable trust with a local charity as beneficiary.

As the SPC Law was very restrictive and more costly than offshore alternatives, there were numerous complaints from market participants and establishment of TMK was minimal. This led to the Law being revised and renamed the “Law Concerning the Securitization of Assets (Asset Securitization Law)” in May 2000, becoming effective from January 2001.

The major changes made under the Asset Securitization Law were: the assets that can be securitized were greatly expanded; minimum capital of the TMK was reduced from 3 million yen to 100,000 yen, the equivalent of establishing an exempted company in the Cayman Islands; registration of the TMK with the Financial Reconstruction Commission was reduced to submission to the Prime Minister; restrictions on borrowing and changes to the asset securitization plan were relaxed; the securities that can be issued were expanded to include convertible special bonds (*tenkan tokutei shasai*) and special bonds with rights to accept new preferential securities (*shinyuusen shusshi hikiukeken tsuki tokutei shasai*); and a trust form of SPV called a special purpose trust (*tokuteki mokuteki shintaku*) and a

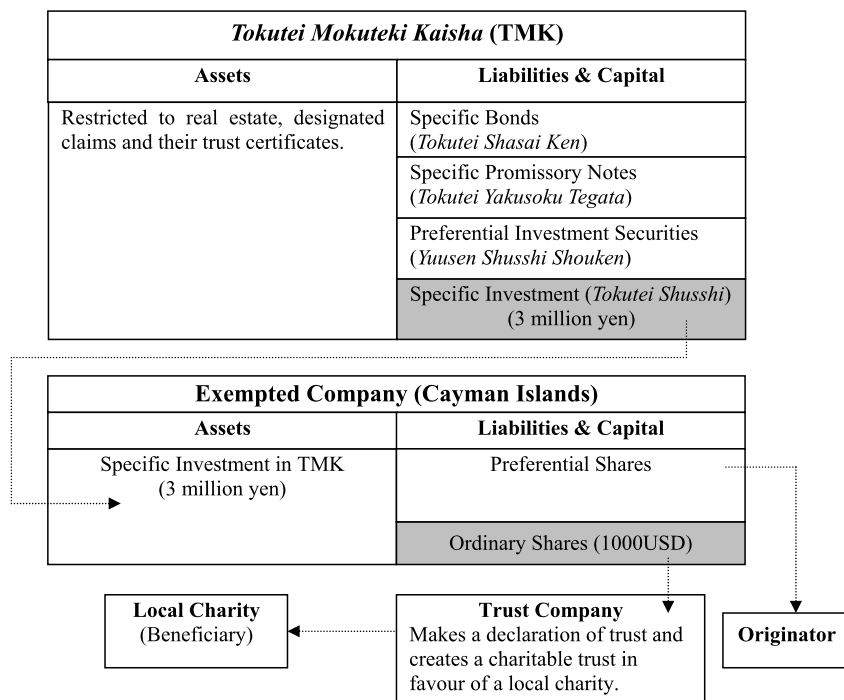


Fig. 3.5. Outline of the SPC Law and Bankruptcy Remoteness.

Japanese version of a charitable trust referred to as a specific equity trust (*tokutei mochibun shintaku*) were added into the Law (Yamazaki, 2002).

Since this Law has become effective there has been a big increase in the number of securitizations that are using TMK established under this Law as the SPV. However, despite the fact that the new Law contains provisions to achieve bankruptcy remoteness by placing the capital of the TMK in a Japanese version of a charitable trust, very few, if any, schemes actually utilize this trust and still eventually place the capital of the TMK in a charitable trust established in the Cayman Islands.

While it was not enacted for securitization purposes, recently it has become popular to use intermediary corporations (*chuukan houjin*) as an alternative to the Japanese version or Cayman Islands charitable trust (METI, 2004). Intermediary corporations are established under the "Intermediary Corporations Law" enacted in June 2001, taking effect from April 2002 and according to Article 2 they are corporations which are designed to maximize profits common to its members, but

<i>Tokutei Mokuteki Kaisha (TMK)</i>	
Assets	Liabilities & Capital
Specific Assets <i>(Tokutei Shisan)</i> Assets that are purchased by the TMK to undertake the securitisation outlined in the Asset Securitisation Plan.	Specific Borrowing <i>(Tokutei Mokuteki Kariire)</i>
	Specific Bonds <i>(Tokutei Shasai Ken)</i> • Straight Bond <i>(Futsuu Shasai)</i> • Convertible Special Bonds <i>(Tenkan Tokutei Shasai)</i> • Special Bonds with Rights to Accept New Preferential Securities <i>(Shinyuusen Shusshi Hikiukeken Tsuki Tokutei Shasai)</i>
	Specific Promissory Notes <i>(Tokutei Yakusoku Tegata)</i>
	Preferential Investment Securities <i>(Yuusen Shusshi Shouken)</i>
	Specific Investment <i>(Tokutei Shusshi)</i>
	Can be placed in a Specific Equity Trust <i>(Tokutei Mochibun Shintaku)</i>. ▼

Fig. 3.6. Outline of the Asset Securitization Law.

not to disburse its surplus to them. Hence, this makes them an ideal alternative to a charitable trust.

Currently, under Japanese accounting standards, TMK are granted exemption from consolidation of both the originator and investors (Article 3 of the Specific Treatment for Revision of the Scope of Subsidiary Companies and Related Companies under the Consolidated Financial Statement System). However, there has been on-going debate over whether TMK should be consolidated since Enron's abuse of SPV in 2000 and more recently as their use becomes more and more widespread and the possibility of abusing them for window dressing purposes increases (JICPA, 2002, 2005).

2.2.3. Servicer Law Traditionally, the collection of bad loans in Japan was within the domain of professional gangsters and lawyers, rather than financial in-

stitutions. While under Articles 72 and 73 of the “Practicing Attorney Law (Law No. 205 of 1949),”⁴ only lawyers were legally permitted to undertake third-party servicing, the collection of bad loans was lucrative business for both gangsters and lawyers, with both parties reluctant to give up their share of the market. However, when non-performing loans created during the bubble period began to pile up, the current framework became a hindrance to their effective disposal and the idea of introducing a servicer system began in late 1997.⁵ The idea was to create a system, which would not only speed up the disposal of non-performing loans, but also be useful in developing the securitization market (Kurokawa and Ishiyama, 2002, p. 5). “The Law Concerning Special Measures for Servicing Business (Servicer Law)” was subsequently enacted in October 1998 and became effective from February 1999.

Figure 3.7 shows the basic outline of the Servicer Law, which requires those wishing to establish a company as a servicer (*saiken kaishuu kabushiki kaisha*) to obtain a permit from the Minister of Justice, after meeting strict conditions about minimum capital of 500 million yen (equivalent to a large company (*daigaisha*) under the Commercial Code), one lawyer director and non-involvement of gangsters in controlling, performing and directing the company’s activities. Before issuing a permit, the Minister of Justice will seek opinions from the Commissioner General of the National Police Agency, regarding the possibility of gangster involvement, and the Japan Federation of Bar Associations, regarding the eligibility of the lawyer director, unless the lawyer has a recommendation for such a director post from a Bar Association.

Under Article 12 of the Servicer Law, unless otherwise permitted by the Minister of Justice, the scope of activities that may be undertaken by a servicer was limited to the collection of “specific financial claims (*tokutei kinsen saiken*)”, mainly the financial claims of financial institutions and certain lease and credit claims, defined in Article 2. As companies began to be issued with permits and undertake the activities permitted under this Law, it became apparent that the definition of “specific financial claims” had been defined too narrowly and was causing practical problems and hindering future market development (Kurokawa and Ishiyama, 2002, pp. 19–20). For example, servicers would receive loans in lots, but not only was it hard to determine if all the loans in a particular lot were within the scope of the Law, the servicer had to hire lawyers to collect the loans on their behalf if they fell outside the scope of the Law.

⁴ English translation available from the Japan Federation of Bar Associations, http://www.nichibenren.or.jp/en/about/pdf/pal_2002.pdf (13 June 2005).

⁵ In Autumn of this year, a mission team, composed of the Deposit Insurance Corporation of Japan and the Jusen Housing Loan Administration Corporation (predecessor of the Resolution Collection Corporation), was dispatched to the U.S.A. to survey American servicers (Kitami, 2004, p. 18).

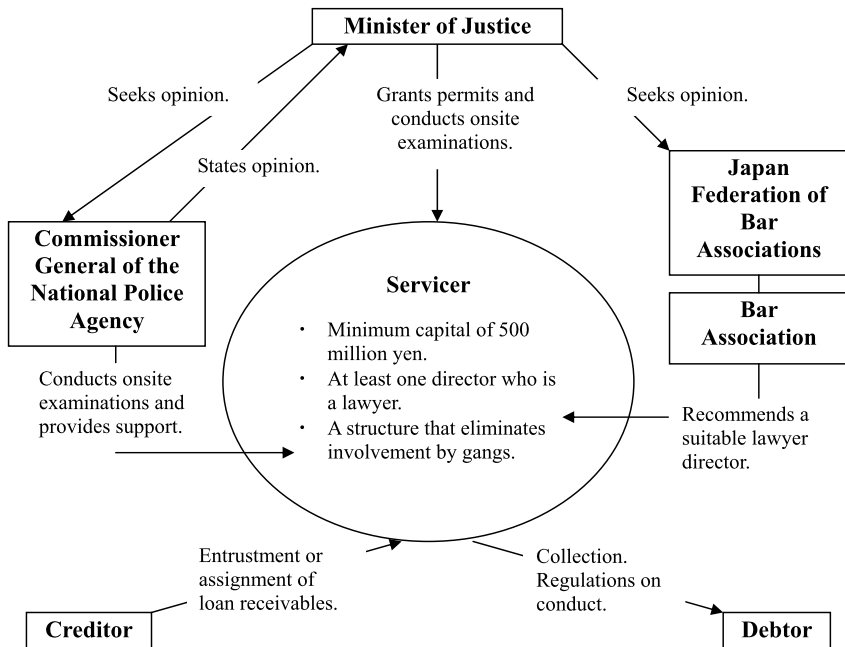


Fig. 3.7. Outline of the Servicer Law. Source: English translation of the figure provided by the Ministry of Justice, <http://www.moj.go.jp/KANBOU/HOUSEI/chousa02.html> (13 June 2005).

Such problems lead the Loan Servicers Association of Japan, established in October 2000, to request that the Servicer Law be revised. As the non-performing loans problem was still an important political issue, the Servicer Working Team that had drafted the original legislation began investigations on possible revisions. After a series of hearings with market participants and related government organizations, the Law was revised in June 2001, with revisions taking effect from September of the same year (Kurokawa and Ishiyama, 2002, pp. 19–20). The revisions broaden the definition of “specific financial claims” in Article 2 to include: all financial claims of lenders registered under the “Money Lending Business Law”; financial claims which are securitized, including the specific assets stipulated in the SPC Law; and financial claims held by those undergoing bankruptcy proceedings.

As of 31 December 2004, there were 89 companies⁶ that have been issued with a servicer permit. Companies seeking a permit include financial institutions, consumer finance companies, foreign operated companies and the Resolution and Collection Corporation (RCC), which was established to collect the loans of bankrupt financial institutions.

2.3. Stage 3: Amended Trust Business Law

While the Perfection Law, the Asset Securitization Law and the Servicer Law are the three pillars of legislation that were enacted to create the securitization market, other legislation has subsequently been introduced to expand the market; the most important piece of legislation being the Amended Trust Business Law which was enacted in November 2004, becoming effective in December of the same year.

The Trust Business Law was enacted in 1922 along with the Trust Law and both Laws have remained largely unaltered since this time. Trusts established under the Trust Law have been effective in meeting the bankruptcy remoteness requirements for securitization and are a popular choice as the SPV. However, while under the Trust Law it is possible to place any asset into a trust, under the Trust Business Law the assets that the trustee could be entrusted with were restricted by Article 4 to money, securities, monetary claims, chattels, land and property. In effect, this meant that the only assets that could become trust assets were restricted to those outlined in the Trust Business Law (Kinyuu Shingikai Kinyuu Bunkakai Dainibukai, 2003, pp. 2–3).

As the world becomes more focused on the knowledge-economy of the 21st Century, the importance of patents and other forms of intellectual property and their commercialization has increased and is leading to financing techniques like securitization of patents. Japanese businesses are holders of numerous patents both within and outside of Japan, but lending based on real estate collateral and guarantees was so strong that the idea of lending based on intellectual property has been non-existent until recently. Beginning in 1995, the predecessor of the Development Bank of Japan and other private banks began to lend based on intellectual property, but at the time it was difficult to value intellectual property causing financing in this area to be slow in gaining popularity (Kobayashi, 2004, p. 5).

In 2002, the Prime Minister released the Intellectual Property Policy Outline,⁷ which aims to make Japan into a “nation built on intellectual property”. This pol-

⁶ An updated list of servicers can be obtained from the Ministry of Justice, <http://www.moj.go.jp/KANBOU/HOUSEI/chousa15.html> (15 June 2005).

⁷ An English version of this Intellectual Property Policy Outline can be obtained from http://www.kantei.go.jp/foreign/policy/titeki/kettei/020703taikou_e.html#0-2 (12 August 2005).

icy drew great attention towards intellectual property and not only re-stimulated interest in using it as a financing basis, but also led to amendment of the scope of the Trust Business Law to allow for a wider range of assets, including intellectual property, to be handled by the trustee and to allow more entities to undertake trust business. These changes are aimed at creating financing opportunities especially for venture businesses that have great future prospects, but little ability to raise funds based on traditional Japanese lending practices.

2.4. Financial Technology

While the legislation outlined above created the legal framework for securitization, a market cannot be created without a certain amount of financial technology. Most of this technology has not been home-grown, but has entered Japan through foreign owned institutions; a trend that is frequently seen in Japanese history. While it is no surprise that major securities companies, such as Morgan Stanley and Lehman Brothers, and rating agencies, such as Standard and Poors, Moody's and Fitch Ratings, have all played an enormous role in introducing the technology required into the market, other major players include banks, such as Shinsei Bank and more recently Tokyo Star Bank, which were taken over by foreign investment funds when their predecessors went bankrupt.

The former was the Long Term Credit Bank of Japan which was purchased by Ripplewood Holdings and the latter was Tokyo Sowa Bank purchased by the Lone Star Fund. Both banks have been front runners in introducing innovative securitization techniques into Japan. Amongst other schemes, Shinsei Bank created the first collateralized loan obligation (CLO) using a master-trust in 2001 (Shinsei Bank, 2005) and Tokyo Star Bank launched the first whole-business securitization in the financial year ending March 2004 (Tokyo Star Bank, 2004). Both banks have also been offering securitization to SMEs as an alternative way of raising funds (Budge, 2004; Tett, 2003). While this kind of securitization is experiencing its share of hiccups, it is proving to be an effective financing tool for SMEs and the arrangement of such schemes is not only an important source of new revenue for these banks, but also allowed them to support financing to SMEs in a greater way than their immediate post-bankruptcy financial condition would have allowed.

While such banks have become innovators in the market, competition is naturally intense and other participants soon follow in their footsteps. Not only competition, but also the high degree of movement in securitization specialists among market participants, has been leading to the rapid spread of the financial technology needed for market development. Currently, it is not unusual for someone to have learned securitization and other financial engineering techniques at one

institution before being recruited by another to arrange nearly identical schemes. While such a trend may not be unusual in some western countries, this reflects a massive change in the life-long employment (*shuushin koyou*) mentality, where people would work diligently for the same company for their entire career, which has traditionally been highly valued in Japanese society.

While this high liquidity in specialist staff can impact on the bottom line of an individual market participant in the short-term, from the point of view of the market as a whole this activity is playing a vital role in spreading the technology required to support long-term development of the market. However, it has been somewhat disappointing to have attended seminars by major market participants only to meet with an attitude that securitization is a field open only to a select few “elite”. While this kind of attitude is not unusual in Japanese society in general, the desire to protect profits, market share and especially power are no doubt contributing factors. While market participants are working hard to create the market, in future this kind of “elitist” attitude could prove to be a hindrance in raising the next generation of securitization specialists. In the long-term, the spread of knowledge about securitization will be the most important factor in ensuring the market’s continuing development, especially when Basel II takes effect and the need to find investors for the lower, more risky securitization tranches increases.

3. DISTINCTIVE TRENDS AND ISSUES FOR THE FUTURE

3.1. Current Size of the Market

It is very difficult to determine the actual size of the securitization market in Japan due to the large number of private transactions. Ratings agencies provide estimates of market size based on the transactions that they rate and any other data available in the market. Fitch Ratings conservatively estimates that from 1999 through 2004, the market has expanded from around 2 trillion yen to over 5 trillion yen, with further room for expansion in the future (Fitch Ratings, 2005, p. 1). The securities issued include: residential mortgage backed securities (RMBS); commercial mortgage backed securities (CMBS); asset backed securities (ABS) backed by auto-loans, shopping loans, consumer credit and leases; and collateralized debt obligations (CDO).

In 2004, the issuance of RMBS expanded 150% to 2.1 trillion yen making up 39% of the market and issuance is expected to expand in the future led by the activities of the Government Housing Loan Corporation, which are outlined below

(Fitch Ratings, 2005, p. 1). Currently there is strong competition among banks for good housing loan borrowers, stemming from the fact that the housing market in Japan is expected to begin shrinking in 2007 when the baby boom generation reach retirement and their children move into the forties age bracket, reducing the demand for housing loans. Hence, while the housing loans market is expected to be funded more and more by securitization in the future, maintaining profits in a shrinking market will provide many challenges for market participants.

On the commercial mortgage side of the market, issuance of CMBS in 2004 is estimated to be at least 870 billion yen in a total of 37 different transactions. This is an increase of 30% over 2003 and makes up 15% of the market. This expansion was promising due to the “2003 problem” where demand for office space in Tokyo especially, weakened due to the completion of many large office buildings, causing vacancy rates to increase and rents to decline. Techniques, such as non-recourse lending, are now being offered more and more by financial institutions and such techniques are expected to be the underlying force in propelling future issuance of CMBS (Fitch Ratings, 2005, pp. 2–3).

The market for ABS has a longer history than other kinds of securitization in Japan due to the Specified Claims Law and so this sector of the market is the most stable and mature, with only limited potential for future expansion. ABS are backed by consumer credit (12.6%), leases (11.7%), auto-loans (4.3%) and shopping loans (2.7%) and made up approximately 31% of the market in 2004. While this was equivalent to a 21% increase on 2003, market share dropped from 38% (Fitch Ratings, 2005, pp. 2–4).

The final major sector of the market is CDO, which made up 10% of the market in 2004. However, many transactions in this sector are undertaken privately, hence, it is difficult to grasp the size of the sector accurately. In 2004, the amount of each transaction was lower than in previous years, but there was an increase in the number of issues and variety of reference assets. This trend is expected to continue in the future (Fitch Ratings, 2005, pp. 2, 4–5).

Since the Servicer Law was enacted there has been a steady increase in the number of loans, loan amounts, number of debtors and the amounts collected. Tables 3.1–3.3 show the cumulative totals for the activities undertaken by servicers up to 31 December 2004, the percentage of each financial claim handled and the percentage of securitized claims handled by servicer type in the six months up to 31 December 2004.⁸

Up to 31 December 2004, over 9 trillion yen has been collected by servicers. However, even in the most recent six-month period securitized claims make up

⁸ Data about servicers is provided in semi-annual press releases made by the Ministry of Justice. These press releases are in Japanese and can be accessed from <http://www.moj.go.jp> (23 June 2005).

Table 3.1
Cumulative Totals for Servicer Activities to 31 December 2004

Servicer Ownership (main shareholder)	Number of Servicers	Number of Claims	Claim Amount (billions of yen)	Number of Debtors	Amount Collected (billions of yen)
Financial Institutions	21	7,950,405	46,536	7,472,497	5,479
Credit, Lending and Lease Companies	22	13,465,002	19,609	13,052,298	1,063
Foreign Companies	16	236,236	46,522	126,362	2,824
Management Co-operatives	3	838,947	752	836,729	18
Real Estate, Independents, Other	27	627,374	16,311	345,964	519
Total	89	23,117,964	129,730	21,833,850	9,903

Source: English translation of the data provided in a press release by the Ministry of Justice in March 2005, <http://www.moj.go.jp/> (13 June 2005).

Table 3.2
Types of Claims Serviced

Financial Claims	Number of Claims	Claim Amount
Financial Claims of Financial Institutions	42.2%	74.7%
Lease and Credit Card Claims	43.9%	1.3%
Securitized Claims	0.4%	11.7%
Financial Claims of Bankrupt Companies	0.3%	0.1%
Redemption Rights, Other	13.2%	12.2%

Percentages for the period 1 July–31 December 2004.

Source: English translation of the data provided in a press release by the Ministry of Justice in March 2005, <http://www.moj.go.jp/> (13 June 2005).

a very small percentage of the claims handled, with securitized claims mostly handled by servicers established by foreign companies and financial institutions.

As the number of non-performing loans declines, it is expected that many of these servicers will become more and more involved in collecting securitized claims as securitization and third party servicing take hold in Japan. From the per-

Table 3.3
Securitized Claims by Servicer

Servicer Ownership	Number of Claims	Claim Amount
Financial Institutions	56.9%	27.3%
Credit, Lending and Lease Companies	23.0%	12.4%
Foreign Companies	18.9%	59.3%
Management Co-Operatives	0.4%	0.0%
Real Estate, Independents, Other	0.7%	0.9%

Percentages for the period 1 July–31 December 2004.

Source: English translation of the data provided in a press release by the Ministry of Justice in March 2005, <http://www.moj.go.jp/> (13 June 2005).

spective of a researcher who has been involved in this area of the securitization market, it has been interesting to watch how the market has slowly moved in the last few years from one where financial institutions would provide all services internally, with most originators also undertaking the servicing of claims that they have securitized, to a market that is starting to see the benefits that come from specialization in and outsourcing of servicing functions, not only for securitized claims, but also for non-securitized claims.

3.2. Government Housing Loan Corporation

In the US, government and government-sponsored organizations such as Ginnie Mae, Fannie Mae and Freddie Mac have contributed extensively to the creation of the securitization market for home loans. In Japan, to date there has been no equivalent organization, but the closest organization is the Government Housing Loan Corporation (GHLC) which was established in 1950 to provide funds for the construction and purchase of residential housing which was in short supply following World War II. In subsequent years it has supplied home loans to those borrowers who are unable to raise funds through banks and other financial institutions. It is a government owned financial institution under the jurisdiction of the Ministry of Land, Infrastructure and Transport (MLIT) and the bulk of its capital comes from the Fiscal Investment and Loan Program (FILP).⁹

In April 2000, the Government Housing Loan Corporation Law was amended to expand the funding of the GHLC and this made it possible for the GHLC to issue MBS which contain their guarantee. From March 2001 through to September

⁹ In the GHLC balance sheet as of 31 March 2004, more than 90% or 57 trillion yen of funds came from FILP.

2005, there have been a total of 35 issues of GHLC MBS¹⁰ and these securities have attracted attention from investors because they have been adopted as one of the securities in the Nomura-BPI index since April 2003.

The Government Housing Loan Corporation Law was further revised in June 2003 and the Purchase-Form (*kaitorigata*) Securitization Support Program and the Guarantee-Form (*hoshougata*) Securitization Support Program were launched in October 2003 and October 2004, respectively. Under these programs, GHLC purchases home loans from private financial institutions for securitization (R&I, 2005, p. 1).

In July 2005 the Housing Financial Services Agency Law was enacted to reform the GHLC into the Housing Finance Services Agency, an independent administrative institution, in April 2007. The Agency will take over the rights and obligations of the GHLC and implement securitization as its main mission. Direct loans will no longer be provided by the GHLC, unless they are difficult for private financial institutions to provide, but the Agency will ensure a smooth supply of funding to the home loan market through securitization and operate much like its American forerunners (GHLC, 2005).

3.3. Tokyo-CLO

After the bubble economy burst in 1991, one of the most affected areas of the economy was small and medium sized enterprises (SME), which number around 3 million and make up over 90% of companies in the economy. However, as non-performing loans began to pile up, banks became more and more reluctant to lend to SMEs and their bankruptcies soon escalated. In 1999, Governor Ishihara of the Tokyo Metropolitan Government (TMG) proposed the creation of a financial market for SMEs.¹¹ The Financial Market Plan was designed to bring together SMEs and banks by fostering a securitization market for SME loans and bonds, especially loans and bonds of those companies with great prospects, but little access to bank financing due to insufficient collateral (TMG, 2005).

The first collateralized loan obligation (CLO) of SME loans backed with a guarantee from the Tokyo Metropolitan Credit Guarantee Corporation were issued under this scheme in fiscal 2001. This issue has been followed by subsequent issues and a CLO of unsecured SME loans was launched in March 2002, followed by a collateralized bond obligation (CBO), consisting of a pool of privately issued SME bonds, launched in March 2003. These schemes are proving to be beneficial

¹⁰ Ratings methodology and ratings reports are available in English from Ratings and Investment Information, Inc. (R&I), <http://www.r-i.co.jp/eng/index.html> (30 September 2005).

¹¹ Limited information is available in English from the following website: <http://www.sangyo-rodometro.tokyo.jp/kinyu/clo/index2.htm> (30 August 2005).

to both banks and SMEs and the participation in the later CBO not only provides SMEs with the opportunity to raise funds, but to appeal their creditworthiness to the international market. For companies wishing to publicly issue shares in the future, the issue of private bonds is the first step in gaining knowledge about direct funding and also has an investor relations effect (TMG, 2005).

Over the past six years a total of more than 450 billion yen has been raised by 10,200 SMEs under this program (TMG, 2005). While it is unusual for local governments to get involved in the financial sector, due to the success of the Tokyo-CLO, similar CLO schemes have also been conducted by the local governments in Osaka Prefecture, Osaka City and Fukuoka Prefecture and are proving beneficial in stimulating the local economy in these prefectures. Continued success should lead to other prefectures following suit.

3.4. Credit Risk Database

Lending in Japan has traditionally been highly focused on the collateral and guarantees that are provided for the loan and hence Japanese financial institutions have not been skilled at measuring and pricing the associated credit risk. The bursting of the bubble economy was a very painful way for financial institutions to learn that their lending practices were by no means fail-proof and that they would need to bridge the financial technology gap. However, as there has always been a high degree of privacy in the Japanese financial system, there was not sufficient data available to price credit risk effectively. This lack of effective pricing of credit risk has also been a hindrance in the securitization market as it is difficult to price securities that are backed by loans with uncertain prices.

Hence, the Credit Risk Database (CRD) was established in March 2001 under the leadership of METI and the Small and Medium Enterprise Agency in order to improve the measurement of credit risk to ensure a smooth supply of funds to SMEs. The database is made up of financial, non-financial and default information provided periodically from over 200 members, including credit guarantee organizations and financial institutions, about more than 1 million SMEs, 70% of which have annual turnover of less than 300 million yen. Members are in return provided with data inputs for credit risk models and various financial and management indexes (CRD, 2005). This database is expected to contribute to the effective pricing of loans to SME and subsequently the effective pricing of securitization instruments.

3.5. Secondary Market

In 2003, the Bank of Japan created a Securitization Market Forum to investigate the reasons why the securitization market in Japan still seems to be underutilized. A report was issued in April 2004¹² outlining the issues that need to be resolved in the future, including the creation of a secondary market for securitized instruments. While one of the expressions for securitization in Japanese literally means liquidization (*ryuudouka*), the lack of a secondary market has actually made securitization instruments highly illiquid securities with most investors buying and holding the instruments until maturity.

As mentioned above, a big hindrance in creating a secondary market is the lack of information available about both the underlying assets and the securitization instruments. Beginning in April 2004, the Bank of Japan has started to create a database of new issues and publishes this information monthly.¹³ However, contributions to the database are made voluntarily and there are many transactions which remain undisclosed. Hence, while the Bank of Japan and other central and local government organizations, such as TMG, are taking an active role in trying to encourage further development of the market, much of what is achieved in the future will depend largely on the efforts and attitudes of market participants.

CONCLUSION

This paper painted the “big picture” of the securitization market in Japan. As Japan is a country which values conformity through the creation of laws and regulations, legislation was enacted in several stages to create the market and reflects the problems inherent in the financial system at the time of enactment. The front-runner of securitization legislation was the Specified Claims Law which was enacted to provide lease and credit companies greater access to funding sources upon the bursting of the bubble economy. While most securitization markets around the world began from securitization of home loans, the enactment of this legislation meant that the securitization market in Japan began from securitization of lease and credit claims.

During the 1990s, as the non-performing loans problem left in the bubble economy’s wake escalated, further legislation for the perfection of claim assignments, SPV and servicing was enacted to alleviate the problem. The subtle creation of

¹² This report can be accessed in Japanese from the Bank of Japan website: <http://www.boj.or.jp/seisaku/04/data/mpo0404c.pdf> (12 August 2005).

¹³ This database can be accessed in Japanese from the Bank of Japan website: <http://www.boj.or.jp/seisaku/credit/sec.htm> (12 August 2005).

complicated rules and regulations is common in Japan and an interesting feature of the legislation enacted is the intricate details contained in the Servicer Law to prevent the possible involvement of gangsters who have traditionally been a persistent hindrance in the Japanese financial market.

However, while Japan is notorious for creating complicated legislation, the legislation in question was too restrictive and led to complaints from market participants and amendments soon after enactment. More recently, the Business Trust Law has also been amended to allow for securitization and other forms of financing based on intellectual property. Traditionally, lending in Japan has been heavily reliant upon real estate collateral and guarantees. Hence, this is a new form of financing that is expected to allow venture companies greater access to funding opportunities.

Naturally, the enactment of laws for securitization was a welcome move, but without the introduction of financial engineering techniques, it would not have been possible to create a market. Like many other areas throughout Japanese history, this technology has been transferred to Japan from overseas, especially through bankrupt institutions taken over by foreign investment funds.

It is difficult to determine the actual size of the securitization market due to the large number of non-disclosed transactions, but it is estimated to have expanded to more than 5 trillion yen by 2004, with most varieties of securitization instruments being issued to varying degrees. Since 2000, the GHLC has become an important player in the home loans sector of the market and this role will be further enhanced when it is reformed into the Housing Finance Services Agency in 2007 and its main objective will be to support the market for home loans through securitization.

The TMG has also been involved in the market through the creation of a financial market for SMEs in 2000 which utilizes securitization. While it is not usual for local governments to be involved in the financial market in this manner, the success of the program has also led other local governments to introduce similar schemes in order to revitalize funding for SMEs which make up over 90% of all corporations in Japan and who were the worst hit sector of the economy as financial institutions became reluctant to lend after the bubble economy burst. Fees from arranging these transactions are also an important source of revenue for financial institutions and such schemes allows them to aid financing to SMEs without being exposed to all the risk. The creation of the CRD, an extensive database about SMEs, is also expected to be a great source of information for ensuring the correct pricing of SME credit risk and this in turn will ensure more efficient pricing of securitization instruments backed by loans and bonds of SMEs.

As the market moves forward, one of the big issues is the creation of a secondary market whose development has been hindered to date by lack of informa-

tion. The Bank of Japan is taking the lead in this area and is creating a public database that can be accessed over the Internet about securitizations launched. As the Japanese approach to creating markets involves the creation of legislation and regulations, naturally political forces will continue to have an influence on the market's future development, but at least for the present moment the stance of legislators is positive meaning that the biggest factor going forward will be the efforts and attitudes of the players in the market. Like all financial markets, techniques come and go and no doubt securitization will continue to be utilized as long as it is profitable for market participants.

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Chapter 4

RISK MANAGEMENT AND DERIVATIVE USAGE IN JAPAN AND NEIGHBOURING ASIAN AND PACIFIC COUNTRIES

Martin Young and Fong Mee Chin

1. INTRODUCTION

As the global economy becomes more established and financial markets become more integrated, risk management continues to become more important. Risk management covers a wide range of activities but, specifically, we are concerned with the management of the risks faced by businesses and individuals through shocks to exchange rates, interest rates, equity prices, and, to a lesser extent in this article, commodity prices. Any price movement in any asset carries a risk for those exposed to that asset and it is often prudent to hedge against that risk if possible. The process of risk management requires that the appropriate risk management tools are in place and easily accessible, however, and these risk management tools need to be developed for individual markets. Derivative products are the mainstay for risk management globally and derivative products can be traded either within a formally structured marketplace or, more informally in an “over-the-counter, OTC” setting. Foreign exchange forward contracts and interest rate and currency swap trading is almost always OTC, particularly in the Asia-Pacific region. The focus of this article will be on the formally structured derivative markets and the role they play in risk management in Japan and neighbouring Asian and Pacific countries.

Financial derivatives and commodity derivatives are traded on many official exchanges throughout the world. The trading of financial derivatives is a relatively new development globally, however. The first official commodity derivatives trading in the United States began in Chicago at the Chicago Board of Trade in 1849. However, the first financial derivatives trading did not begin until 1972, when the

Chicago Mercantile Exchange began trading futures contracts on seven foreign currencies. In Europe, the oldest financial derivatives market was the London International Financial Futures Exchange, or LIFFE, which began trading financial futures in 1982. Recently LIFFE became part of the Euronext group of derivative exchanges.

In terms of financial product offerings and development, the major markets of the United States and Europe started with currency and then interest rate products, with equity-based products being introduced at a later date. The trading of currency derivatives was not necessary prior to the breakdown of the Bretton Woods agreement on currency convertibility, which occurred in August 1971 when President Nixon closed the window on converting US dollars directly into gold. This act led to the floating of all the major currencies by March 1976. The floating of the major currencies and the inflationary impact of the oil shocks of the 1970s also greatly increased interest rate risk, leading to a greater need for interest rate derivatives as well as currency derivatives. It could be argued that the need for equity-based derivatives has been present since the introduction of equity markets but these are an even more recent development than the currency and interest rate derivatives, driven mainly by the huge growth in equity funds management through the 1980s and 1990s.

It is also interesting to note the differences in structure and product offerings across the derivative exchanges of the United States and Europe. In the United States, derivatives exchanges developed very much independent of other exchanges and trade just derivative products, often both commodity and financial derivatives. In Europe, however, many of the derivative exchanges are directly linked to stock exchanges and there is a more specialized approach to derivatives trading. For example the two largest financial derivatives markets of Europe, Euronext-LIFFE and Eurex, have achieved their position mainly through their dominance of the European short and long-term interest rate derivative markets. The smaller derivatives markets of Europe, however, tend to trade mainly equity-based derivative products and often include commodity derivatives in their product-offering list.

In the Asia-Pacific region the derivative markets developed within a somewhat different time-frame but the history of derivative trading in Asia, Japan in particular, is just as rich as it is in the United States and Europe. Like the United States and Europe, commodity derivatives were the first to trade with Japan being the first to introduce a financial derivative contract. In fact Japan lays claim to trading commodity derivatives before the United States when an exchange for trading rice for future delivery was established in Akamagaseki in 1805. This exchange, however, did not have much in the way of formal structure until 1876 when the

Rice Market Ordinance established the “Akamagaseki Rice Market” in the city of the same name, now known as Shimonoseki.

While there is a long history of commodity derivatives trading in Japan, most commodity derivative markets in Asia developed in the mid to late 1900s. First, it is interesting to note that most commodity derivative exchanges in Asia are just that. That is there is a clear distinction between exchanges that trade commodity derivatives and those that trade financial derivatives. Gold futures are normally traded on commodity derivative exchanges though the Korea Futures Exchange, which is primarily a financial derivatives exchange, also trades gold futures. The main exception to this is the Bursa Malaysia Derivatives Berhad, which trades equity and interest rate derivatives along with Crude Palm Oil and Crude Palm Kernel Oil futures. Malaysia is a major world supplier of these commodities.

There are a substantial number of commodity derivative exchanges in Asia. These have, in general, developed around the need to hedge the commodity price risk of the major exports or imports of their respective countries, as is the case with Bursa Malaysia Derivatives Berhad. A list of these exchanges for which trading data is available, together with the contracts that they trade, is given in Table 4.1. The commodity futures exchanges of Singapore and India are not included in this list as contract volume trading data is not available, but in the case of Singapore, the major contracts traded are based on the rubber industry in neighbouring Malaysia. The commodities exchanges of India focus mainly on the nuts, seeds, oils and spices industries of India with derivative trading in Bombay going back more than one hundred years.

Products to aid in risk management for commodity price exposure are now well developed in many of the Asian countries. The products required for financial risk management in Asian countries, and the exchanges on which to trade them, are in various stages of development. To a large extent, the level of development in any particular country is dependent on the level of openness within the financial markets of that country. The first financial futures contract in Asia began trading in Japan on 19th October 1985. This was the Tokyo Stock Exchange 10-year Japanese Government Bond contract. The first stock futures contracts were introduced in 1986 on the Hong Kong Futures Exchange and the Singapore International Monetary Exchange, now known as Singapore Exchange Derivatives Trading. The first stock futures contract introduced in Japan was the Osaka Stock Futures 50, which started trading in 1987 on the Osaka Securities Exchange. Since then a number of financial derivative markets have developed in Asia. In particular the 1990s saw the introduction and rapid development of financial derivative exchanges in India, Korea and Taiwan. Table 4.2 lists the financial derivatives markets of Asia together with the products that they trade and contract volumes for 2003 and 2004. The real successes have been the financial derivative exchanges

Table 4.1

Commodity Derivatives Market Turnover by Contracts Traded within Asia for the 2003 and 2004 Trading Years for All Exchanges that Are Members of the IOMA/IOCA

		Number of Contracts	
		JAN-DEC 2003	JAN-DEC 2004
Soybeans	Ag	19,287	
Corn	Ag		5,828,045
No. 1 Soybeans	Ag	60,000,808	57,340,803
No. 2 Soybeans	Ag		114,347
Soy Meal	Ag	14,953,398	24,750,958
DALIAN COMMODITY EXCHANGE, China		74,973,493	88,034,153
Copper	Non-precious	11,166,288	21,248,370
Aluminium	Non-precious	2,155,498	6,829,499
Rubber	Ag	26,757,964	9,680,649
Fuel Oil	Energy		2,818,855
SHANGHAI FUTURES EXCHANGE, China		40,079,750	40,577,373
Cotton No.1	Ag		5,988,092
Strong Gluten Wheat	Ag	19,308,856	23,174,538
Hard White Winter Wheat	Ag	30,508,942	19,311,918
ZHENGZHOU COMMODITY EXCHANGE, China		49,817,798	48,474,548
Red Beans	Ag	12,080	12,851
U.S. Soybeans	Ag	41,126	6,305
Non-GMO Soybeans	Ag	622,337	276,396
Refined Sugar	Ag	2,842	2,860
Raw Sugar	Ag	18,956	36,822
Raw Silk	Ag	8,009	6,665
Frozen Shrimp	Ag	1,144,264	1,385,143
Corn 75 Index	Ag	317,561	350,029
Coffee Index	Ag	1,274,190	726,741
Futures		3,441,365	2,803,812
Raw Sugar Options	Ag Opt.	2,931	2,928
Options		2,931	2,928
KANSAI COMMODITIES EXCHANGE, Japan		3,444,296	2,806,740
Red Beans	Ag	30,100	1,439
Imported Soybeans	Ag	409	
Non-GMO Soybeans	Ag	418,476	12,398
Shell Egg	Ag	399,167	798,308
Gasoline	Energy	16,705,638	15,869,951
Gas Oil	Energy		1,056,257
Kerosene	Energy	13,984,740	15,454,906
CENTRAL JAPAN COMMODITY EXCHANGE, Japan		31,538,530	33,193,259

Table 4.1
(Continued)

		Number of Contracts	
		JAN-DEC 2003	JAN-DEC 2004
Cotton Yarn (20S)	Ag	11,681	
Cotton Yarn (40S)	Ag	7,687	
Rubber (RSS3)	Ag	1,550,423	756,411
Rubber (TSR20)	Ag	1,985,225	826,045
Rubber Index	Ag	1,423,491	814,328
Aluminium	Non-Precious	963,464	1,101,198
Nickel	Non-Precious	220,618	344,571
OSAKA MERCANTILE EXCHANGE, Japan		6,162,589	3,842,553
Gold	Precious	26,637,897	17,385,766
Silver	Precious	1,160,565	1,473,370
Platinum	Precious	14,211,824	13,890,300
Palladium	Precious	275,322	438,934
Aluminium	Non-Precious	329,565	321,131
Gasoline	Energy	25,677,079	23,648,587
Kerosene	Energy	13,208,350	13,036,277
Crude Oil	Energy	1,809,711	2,284,572
Gas Oil	Energy	372,977	235,844
Rubber	Ag	3,568,929	1,732,645
Futures		87,252,219	74,447,426
Gold Options	Precious Opt.		64,308
Options			64,308
THE TOKYO COMMODITY EXCHANGE, Japan		87,252,219	74,511,734
U.S. Soybeans	Ag	1,745,697	2,125,458
Non-GMO Soybeans	Ag	6,735,421	9,971,499
Soybean Meal	Ag	52,039	43,553
Arabica Coffee	Ag	5,019,572	4,293,422
Azuki (Red Beans)	Ag	555,190	363,328
Corn	Ag	5,984,743	8,122,448
Refined Sugar	Ag	2,842	2,854
Robusta Coffee	Ag	617,327	427,466
Raw Sugar	Ag	371,896	355,659
Futures		21,084,727	25,705,687
U.S. Soybeans Option	Ag Opt.	17,548	17,758
Corn Options	Ag Opt.	12,214	16,072
Raw Sugar Options	Ag Opt.	5,979	5,405
Options		35,741	39,235
TOKYO GRAIN EXCHANGE, Japan		21,120,468	25,744,922

Table 4.1
(Continued)

		Number of Contracts	
		JAN–DEC 2003	JAN–DEC 2004
Japan Raw Silk	Ag	919,049	239,446
International Raw Silk	Ag	11,581	8,470
Dried Cocoon	Ag	27,368	91
Potato	Ag	894,160	869,589
Vegetables	Ag		47,215
YOKOHAMA COMMODITY EXCHANGE, Japan		1,852,158	1,164,811
Gold	Precious	56,998	969
KOREA FUTURES EXCHANGE		56,998	969
Crude Palm Oil (FCPO)	Ag	1,434,713	1,378,334
MALAYSIA DERIVATIVES EXCHANGE BERHAD		1,434,713	1,378,334
Rice	Ag		13,666
Rubber	Ag		14,890
Tapioca	Ag		
AGRICULTURAL FUTURES EXCHANGE OF THAILAND			28,556
(Commenced trading on 28 May 2004)			

Note. Contract volume data is not available for the Singapore Commodity Exchange, National Multi-Commodity Exchange of India and the Bombay Commodity Exchange.

Source: Institute for Financial Markets, Futures and Options Fact Book, Monthly Vol. *Annual Report and Statistics 2004*, World Federation of Exchanges.

of Korea, Japan, and Singapore, though Singapore is finding itself operating in an ever more competitive environment as the major trading on this exchange is on derivative products for which the underlying asset is outside of Singapore. This issue will be looked at in more detail later in this article. As shown in Table 4.5, the financial derivative markets in these countries accounted for 44.37%, 32.68%, and 17.98%, respectively, of total market value for Asia in 2004. On a per capita basis the Singapore Exchange Derivatives Trading has been the most successful financial derivatives exchange in Asia to date.

In the rest of this article we look at the process of risk management and the derivatives used in the Asian market to manage this risk. We also look more closely at the financial derivative markets in Japan and the Yen-based products traded outside of Japan. We also look more closely at the highly successful Sin-

gapore Exchange Derivatives Trading Limited, and consider future trends in the derivatives markets of Asia.

2. WHAT IS RISK MANAGEMENT?

Risk management is all about the need to control the amount of risk one is exposed to, and risk will always exist for any party that has an exposure to an adverse price movement in any particular asset. These assets could be real assets such as commodities, or financial assets such as interest rates, equities or currency values. Any party that takes a position on a derivative product with the aim of reducing their exposure to the risk they face is hedging their position. Generally any particular party is going to want to be exposed to some level of risk, as it is by taking risk that higher returns can be achieved. However, it is always important to understand just how much risk a party is exposed to and to decide carefully just how much risk is appropriate to take, that is the risk appetite of the particular party. Often the best way of reducing risk is through a derivatives market.

Derivatives markets have two major types of player operating within them, those who need to hedge a position and those that wish to speculate. Every time a trade is made there will either be hedgers, speculators, or both involved. If two speculators have opposing views, then both parties to a trade could be speculators. If two parties both wish to hedge opposite positions, then both could be hedgers. While many of the participants in derivative markets are hedgers, no contract traded on a derivative market can survive without the involvement of speculators. Speculators provide liquidity to the market by usually providing the other side to a contract that a hedger wishes to enter into. Also many contracts are written where speculators are on both sides of the contract on account of holding differing views. Liquidity can also be provided to the derivative marketplace by market makers. The market maker takes the other side of contracts when there is no other party to take on this role. In Asia, market making is not as prevalent as it is in the United States but there are those willing to provide liquidity in this way either on a formal or informal basis.

Risk Management Requirements in Asia-Pacific

Risk management requirements in Asia are similar to other parts of the world. For commodities the requirements relate to the major imports and exports for individual countries and the region. Not surprisingly gasoline is a major commodity contract in Japan given that country's heavy reliance on imported fuel. In China,

on the other hand, the major commodity contracts are based on agricultural produce.

For financial derivative products the focus is on interest rate and equity-based derivative products with equity-based derivatives showing the strongest growth in recent times. Currency derivative products are only traded in Japan and Korea and only on the US Dollar cross rate. It is interesting to note the environment required for an active currency derivative market. First, the main competitor to currency derivative exchange trading is the banking sector, which provides forward cover on foreign exchange transactions. This forward cover can be tailored to the needs of each individual client. Unless the cover required is very large, the banks can usually provide more appropriate cover than a derivatives exchange. The next point to note is that currency risk needs to exist and speculators need to be prepared to take on that risk. Currency derivative trading in Europe has declined dramatically since the introduction of the Euro. If a currency is fixed to another currency, such as was the case, until recently, with the Malaysian Ringgit and the Chinese Yuan being pegged to the US Dollar, then the exchange rate risk faced between these currencies and the US Dollar is zero unless clear pressure exists for a change to the peg. The risk against other currencies can be hedged with that currency's cross to the US Dollar. There will be little to no demand for hedging the local currency itself and speculators will have no interest unless the peg comes under pressure. It is also difficult to develop currency derivative products on currencies that operate under a managed float system for the same basic reasons. Of all the currencies in Asia, the Japanese Yen is the only one that is free floating and even this currency has its problems for speculators. Given the fact that Japan continues to run very large trade surpluses there is plenty of foreign exchange available for the Central Bank of Japan to enter into the market to manipulate the value of the Yen. Speculators therefore feel that the profits they can achieve by trading in the Yen are likely to be capped by the actions of the Central Bank of Japan. The move by China to run a managed float on the Yuan is likely to give some impetus to the currency derivatives market in Asia, but this will probably take time to work through. A free-floating Yuan in future will definitely change the dynamics of this market when it occurs.

The demand for interest rate derivative products tends to be driven by the size of a country's government security and bond markets, the use of local currency denominated fixed interest securities offshore, and by the underlying volatility in interest rates. The major interest rate derivative trading in Asia takes place in Singapore and Japan. For Japan the main interest is local but Singapore provides a successful market for international interest rate derivatives, in particular the Eurodollar and Euroyen interest rates. The fact that Japanese Yen are traded in such large volume in the Eurocurrency markets has led to very significance interest rate

derivate trading in Euroyen and Japanese Government security-based products in both the United States and London in particular.

The major growth in recent times in financial derivatives has been with the equity-based products and this has been driven, to a large extent but the rapid growth in funds under management in the area. The major stock markets in Asia all have equity index-based derivative products, the most successful of these being Korea's KOSPI 200, which trades both futures and options. Individual equity options are also becoming more popular in Asia, though the trading activity for these is well below that for the index-based products.

3. FINANCIAL DERIVATIVE USE IN ASIA-PACIFIC MARKETS

In this section we look more closely at the financial derivatives exchanges within the Asia-Pacific region. While a large amount of derivatives activity relates to over-the-counter transaction, particularly for currencies, interest rates and swaps, the exchanges provide the public face to derivatives trading in Asia-Pacific. Those exchanges that offer financial derivative products are listed in Table 4.2 together with the products they offer and the trading volumes for 2003 and 2004.

Financial Derivative Trading in Asia-Pacific—Country Analysis

India India has two derivatives markets that trade in financial derivatives. The largest of these is the financial derivatives market run by the National Stock Exchange of India, which started trading in equity index futures in the middle of 2000. In 2001 the exchange commenced trading in equity index options, and individual equity options and futures. An interest rate futures contract was also launched in June of 2003 but the volume for this contract was very low in that year and in 2004 there were no trades in this contract at all. The equity-based products, however, have seen solid growth in contracts traded, and in 2005 a new contract was launched on the BANK Nifty Index. This pattern of financial derivatives trading is very typical with the main interest and growth tending to be in equity-based financial derivatives.

The Bombay Stock Exchange runs the other financial derivatives exchange in India. Financial derivatives trading started here at around the same time as for the National Stock Exchange of India; however, volumes have not been nearly as large as for their competitor. The Bombay Stock Exchange has shown some interesting innovation, however, with the introduction of weekly options on four leading companies and the market index product, Sensex. These options have a

Table 4.2

Financial Derivatives Market Turnover by Contracts Traded within Asia for the 2003 and 2004 Trading Years for All Exchanges that Are Members of the IOMA/IOCA

		Number of Contracts	
		JAN–DEC 2003	JAN–DEC 2004
Interest Rate	Interest	10,781	
S&P CNX Nifty Index	Equity	10,557,024	23,354,782
All Futures on Individual Equities	Indiv. Equity	25,573,756	44,051,780
Futures		36,141,561	67,406,562
Options on S&P CNX Nifty Index	Equity Opt.	1,332,417	2,812,109
All Options on Individual Equities	Ind. Equity Opt.	5,607,990	4,874,958
Options		6,940,407	7,687,067
NATIONAL STOCK EXCHANGE OF INDIA		43,081,968	75,093,629
SENSEX Index Futures	Equity	N/A	514,255
Stock Futures	Indiv. Equity	N/A	38,378
Futures			552,633
SENSEX Index Options	Equity Opt.	N/A	56,046
Stock Options—Put	Ind. Equity Opt.	N/A	6,029
Options			62,075
BOMBAY STOCK EXCHANGE, India			614,708
Eurodollar	Interest	18,802,104	8,241,545
Singapore Dollar Interest Rate	Interest	58,353	42,486
Nikkei 225	Equity	7,098,920	7,769,675
Straits Times Index	Equity	6,601	1,830
S&P CNX Nifty Index	Equity		38
MSCI Singapore Index	Equity	1,046,326	1,658,600
MSCI Taiwan Index	Equity	5,455,812	6,998,626
3-Month Euroyen Tibor	Interest	2,015,211	2,490,390
3-Month Euroyen Libor	Interest	110,529	34,547
5-Year Singapore Government Bond	Interest	14,598	446
10-Year Japanese Government Bond	Interest	92	86
Mini Japanese Government Bond	Interest	745,091	931,110
All Futures on Individual Equities	Indiv. Equity	549	
Futures		35,354,186	28,169,379
3-Month Euroyen Tibor Options	Interest Opt.	13	
Mini Japanese Government Bond Options	Interest Opt.	2,074	1,990
MSCI Taiwan Index Options	Equity Opt.	40,274	41,971
Nikkei 225 Option	Equity Opt.	249,087	205,417
Options		291,448	249,378
SGX DERIVATIVES TRADING LTD, Singapore		35,645,634	28,418,757

Table 4.2
(Continued)

		Number of Contracts	
		2003	2004
TAIEX Futures	Equity	6,514,691	8,861,278
Mini TAIEX Futures	Equity	1,316,712	1,943,269
Taiwan Stock Exchange Electronic Sector Index Futures	Equity	990,752	1,568,391
Taiwan Stock Exchange Bank & Insurance Sector Index Futures	Equity	1,126,895	2,255,478
Taiwan 50 Futures Index	Equity	4,068	6,157
10-Year Government Bond Futures	Interest		67,705
30-Day Commercial Paper Interest Rate Futures	Interest		209,561
Futures		9,953,118	14,911,839
TAIEX Options	Equity Opt.	21,720,083	43,824,511
All Options on Individual Equities	Ind. Equity Opt.	201,733	410,026
Options		21,921,816	44,234,537
TAIWAN FUTURES EXCHANGE		31,874,934	59,146,376
Hang Seng Index	Equity	6,800,360	8,601,559
Mini Hang Seng Index	Equity	1,248,295	1,457,681
H-Shares Index	Equity	47,941	1,743,700
MSCI China Free Index	Equity	190	
Dow Jones Industrial Average	Equity	9,091	2,673
One Month HIBOR	Interest	310	733
Three Month HIBOR	Interest	47,799	58,307
Three Year Exchange Fund Note	Interest	2,012	2,225
All Futures on Individual Equities	Indiv. Equity	18,654	17,274
Futures		8,174,652	11,884,152
Hang Seng Index	Equity Opt.	2,118,792	2,029,068
Mini Hang Seng Index	Equity Opt.	32,131	26,882
H-Shares Index	Equity Opt.		77,758
All Options on Individual Equities	Ind. Equity Opt.	4,220,638	5,611,832
Options		6,371,561	7,745,540
HONG KONG EXCHANGES & CLEARING- DERIVATIVES UNIT (HKFE & HKSE)		14,546,213	19,629,692
Nikkei 225 Futures	Equity	13,058,425	14,415,884
Nikkei 300 Futures	Equity	172,862	167,399
Futures		13,231,287	14,583,283
Nikkei 225 Options	Equity Opt.	14,958,100	16,560,874
Nikkei 300 Options	Equity Opt.	234	491
All Options on Individual Equities	Ind. Equity Opt.	45,412	1,481,415
Options		15,003,746	18,042,780
OSAKA SECURITIES EXCHANGE, Japan		28,235,033	32,626,063

Table 4.2
(Continued)

		Number of Contracts	
		2003	2004
3-Month Euroyen TIBOR	Interest	4,155,800	7,259,779
3-Month Euroyen LIBOR	Interest	3,000	3,000
5-Year Yen Swapnote	Interest	205,092	245,049
10-Year Yen Swapnote	Interest	408,025	147,482
U.S. Dollar–Japanese Yen	Foreign		200
Futures		4,771,917	7,655,510
Options on 3-Month Euroyen TIBOR	Interest Opt.		2,000
Options			2,000
TOKYO INTERNATIONAL FINANCIAL FUTURES EXCHANGE, Japan		4,771,917	7,657,510
10-Year Yen Govt Bond	Interest	6,465,073	8,025,268
TOPIX Stock Index	Equity	9,359,047	10,305,318
Electric Appliance Index	Equity	724	741
Bank Index	Equity	140,331	601
Futures		15,965,175	18,331,928
TOPIX Options	Equity Opt.	98,137	17,643
Yen Govt Bond (10-Yr) Options	Interest Opt.	972,518	1,262,994
Options		1,070,655	1,280,637
TOKYO STOCK EXCHANGE, Japan		17,035,830	19,612,565
Korea Treasury Bonds	Interest	10,285,042	7,352,307
5-Year Treasury Bond	Interest	171,538	61
Monetary Stabilization Bond	Interest	207,209	2,621
KOSPI 200	Equity	62,204,783	55,608,856
KOSDAQ50 Index	Equity	727,997	206,221
US Dollar	Foreign	1,506,123	2,090,291
Futures		75,102,692	65,260,357
Korea Treasury Bond Options	Interest Opt.	1,229	
KOSPI 200 Options	Equity Opt.	2,837,724,953	2,521,557,274
KOSDAQ50 Index	Equity Opt.	3	1
All Options on Individual Equities	Ind. Equity Opt.	8,159	1
Options		2,837,734,344	2,521,557,276
KOREA FUTURES EXCHANGE		2,912,837,036	2,586,817,633
Transferred from the Korea SE as of 1/2/04			
3-Month KLIBOR (FKB3)	Interest	126,289	141,969
3-Year Malaysian Government Securities (FMG3)	Interest	781	4,327
5-Year Malaysian Government Securities (FMG5)	Interest	116,221	19,494

Table 4.2
(Continued)

		Number of Contracts	
		2003	2004
10-Year Malaysian Government Securities (FMG10)	Interest	11	
KLSE Composite Index (FKLI)	Equity	331,445	1,088,419
Futures		574,747	1,254,209
MALAYSIA DERIVATIVES EXCHANGE			
BERHAD		574,747	1,254,209

Source: Institute for Financial Markets, Futures and Options Fact Book, Monthly Vol. *Annual Report and Statistics 2004*, World Federation of Exchanges.

life of two weeks starting on a Monday and expiring on the Friday of the following week. Given the low volume of contracts in this market, it is questionable as to whether India is capable of supporting two financial derivatives exchanges at this time.

Singapore We look at the Singapore financial derivatives exchange, Singapore Exchange Derivatives Trading in more detail later in this article, but the following points are worth noting at this stage. First, and most interestingly, only 6% of contracts traded in this market in 2004 related to Singapore-based financial products. This is unique for financial derivatives markets in Asia, and is also the exception globally. The Singapore Exchange uses its time zone to complement other trading locations trading the same products, leading to effective 24 hour trading on major interest rate derivatives in particular. Electronic trading on other financial derivative exchanges is, however, placing increased competition on SGX Derivatives Trading going forward.

Taiwan Despite its prominent place among the Asian Tigers, Taiwan was a late starter to financial derivatives trading with the Taiwan Futures Exchange not being established until the 17th April 1998. The process leading up to this establishment was a rather drawn-out one. It started in 1992 when the Foreign Futures Trading Law was passed allowing for domestic investors to trade in foreign futures and options contracts. This helped build a regulatory and business experience base for the later move towards a home financial derivatives market. Then in early 1997 the Futures Trading Law came into effect paving the way for the establishment of the Taiwan Futures Exchange. While this process took time, it has allowed for the very smooth and successful establishment of this exchange. It is interesting to note

that China, having had financial derivatives trading in the early 1990s, currently does not have a financial derivatives exchange on account of unregulated activity that led to a Government ban on financial derivatives trading in May 1995. It is quite possible that, if China had taken the same path as Taiwan in developing its financial derivatives market, the problems they encountered would not have eventuated.

Once again the main derivatives products traded on the Taiwan Futures Exchange are their equity index futures and options products based on their main stock index. In 2004 trading on these two products accounted for over 89% of total contracts traded. The exchange also trades interest rate futures but for 2004, trades on these contracts were just under 5% of total contracts traded.

Hong Kong The Hong Kong derivatives exchange was one of the first in Asia to start trading financial derivatives. This occurred in 1986 when an equity index futures contract was introduced. In 1995 individual stock options contracts were introduced. Once again the bulk of trading on the Hong Kong Exchanges and Clearing-Derivatives Unit is in equity index futures and options though the individual stock options contracts are also very popular. Trading in the major equity index futures and options contracts accounted for approximately 54% of total trades in 2004, while trading in the individual stock options contracts accounted for approximately 29% of total trades. As with Taiwan there is a small amount of interest rate derivative trading in Hong Kong, accounting for about 3% of total contracts traded in 2004.

Japan There are three derivatives exchanges involved in the trading of financial derivatives in Japan, namely the Osaka Securities Exchange, the Tokyo International Financial Futures Exchange and the Tokyo Stock Exchange. Of these the largest player is the Osaka Securities Exchange. The Osaka Securities Exchange started trading financial derivatives with the introduction of the Osaka Stock Futures 50 contract in 1987. The Nikkei 225 futures, introduced in 1988, and the Nikkei 225 options contract, introduced in 1989, superseded this contract. In 1994 the Nikkei 300 futures contract and the Nikkei 300 options contract were introduced. Then, finally, in 1997 the Osaka Securities Exchange introduced options contracts on individual stocks. The Osaka Securities Exchange deals only in equity-based financial derivatives but this has seen substantial growth over the years.

The Tokyo Stock Exchange launched the first financial futures contract in Japan on October 19, 1985. This was the 10-year Japanese Government Bond Futures contract and it was introduced to meet the need from market participants to have a tool to manage interest rate risk. This product remains one of the most actively

traded financial derivative products on the Tokyo Stock Exchange and an equivalent options product is also available. The other major contracts traded here are the equity index futures and options products on the TROPIX stock index. For the year 2004, the Government Bond contracts accounted for approximately 47% of the total contracts traded while the TOPIX contracts accounted for approximately 53%.

While the Tokyo Stock Exchange focuses on its long-term interest rate contracts, the Tokyo International Financial Futures Exchange (TIFFE) focuses on short-term interest rate contracts and interest rate swap contracts. This exchange began trading in 1989 and then in 1996 entered into an agreement with the London International Financial Futures and Options Exchange (LIFFE) to trade the three-month Euroyen interest rate contract. The links between TIFFE and what is now Euronext-LIFFE were further strengthened when, in 2003, an agreement was reached for TIFFE to use Euronext LIFFE's trading platform, LIFFE CONNECT®. By far the major contract traded on the Tokyo International Financial Futures Exchange is the three-month Euroyen interest rate contract. For 2004 trading in this contract made up approximately 95% of total contract trades.

Korea In terms of success stories in the area of financial derivatives markets, Korea and Singapore stand out. Singapore stands out for its success in offering a diverse range of products and Korea for its trading volumes. In terms of products offered, the Korea Futures Exchange is one of only two derivative exchanges in Asia that trades both financial and commodity futures, along with the Malaysia Derivatives Exchange Berhad. It is also one of only two that trade currency derivatives, along with TIFFE. These contracts are a Gold contract and a US Dollar contract.

Equity index futures started trading on the Korea Stock Exchange in May 1996 with equity index options trading from July 1997. The Korea Futures Exchange started operations in April 1999, with the introduction of interest rate, currency and gold derivative products. In January 2004 the equity index products traded on the Korea Stock Exchange were moved to the Korea Futures Exchange leaving Korea with just one exchange for derivative trading. The real success for the Korea Derivative Exchange has been the trading in the equity index KOSPI 200 options. For the year 2004 there were over 2.5 billion trades in this contract, accounting for over 97% of total contracts traded on the exchange. In terms of number of contracts, this was approximately 90% of total contracts traded in Asia for the same year. On a value basis, these trades accounted for approximately 43% of total value traded in Asia for 2004.

Malaysia The Malaysian Derivatives Exchange Berhad is one of the smallest derivatives exchanges in Asia with just 1.2 million contracts traded in 2004, though this was double that traded in 2003. The contracts traded are equity index and interest rate derivatives with the equity index products the most popular. In 2004 equity index derivatives accounted for approximately 87% of total trades.

Derivative trading started in Malaysia in 1980 when the Kuala Lumpur Commodity Exchange started operations. Then in 1995 equity index futures started trading with the introduction of KLOFFE, a derivatives exchange set up for specifically for the trading of financial derivatives. Then in 2001 the two exchanges merged forming the Malaysian Derivatives Exchange Berhad, which is a fully owned subsidiary of the Kuala Lumpur Stock Exchange.

China and Thailand Two significant countries in Asia that do not have financial derivatives exchanges are China and Thailand. Both have commodity exchanges and China did have financial derivatives markets in the early 1990s but these have been closed down for some time as mentioned earlier. There is a very large off-shore market in Yuan-based derivatives products, but not within China itself. With the move to a managed float of the Yuan, there is now more reason than ever to develop a well-structured financial derivatives market in China. Moves are currently underway to re-establish a financial derivatives market in China and this will most likely happen in conjunction with the Shanghai Stock Exchange, which has already applied to trade equity-based derivative products.

Thailand is also moving quickly towards having a financial derivatives market with the coming into effect of the Derivatives Act B.E 2546 in January 2004. This led to the establishment of the Thailand Futures Exchange, which is a fully owned subsidiary of the Stock Exchange of Thailand. Most issues have now been resolved in the establishment of this exchange and it is hoped to commence trading equity index futures and options in the fourth quarter of 2005. Once again this shows just how important equity index products are for the financial markets.

4. YEN-BASED FINANCIAL DERIVATIVE PRODUCTS AND THEIR TRADING

The major free-market economy of the region is that of Japan. It has the longest history of derivative trading, a currency that is one of the three major global currencies, large foreign reserves and large bond and equity markets. While China is certain to challenge Japan's lead to the Asia-Pacific region in years to come, there is still a long way for China to go in terms of deregulation before this can occur.

Given the financial market dominance of Japan in this region it is interesting to consider the derivative markets in which Japanese-based financial derivatives are traded. As well as the trading that takes place on the three Japanese financial derivative markets and on the Singapore Exchange Derivatives Trading, which has already been discussed, Japanese-based financial derivatives are also traded in a significant way on the Chicago Mercantile Exchange and Euronext-LIFFE. Table 4.3 lists the major derivative exchanges where Japanese-based financial derivative products can be traded and shows the contracts that are available in each exchange.

The major financial derivative market outside of Japan for Japanese-based products is the Chicago Mercantile Exchange. Here trading takes place in a number of interest rate and equity products as well as currencies. In fact the CME lists futures currency contracts for Japanese Yen against the Australian Dollar, the Canadian Dollar, the Euro and the Swiss Franc as well as against the US Dollar. There is also a US Dollar/Yen options contract traded there. Trading in Japanese Yen currency contracts started trading at the CME right back at the beginning of currency derivative trading in 1972. In relation to equity contracts the CME trades futures and options denominated in both US Dollars and Yen on the Nikkei 225. For the interest rate derivatives, the 3-month Euroyen TIBOR contract is the most popular.

Euronext-LIFFE, the other major derivatives exchange outside of Asia-Pacific to list Japanese-based derivative contracts, makes a market for 3-month Euroyen TIBOR and 10-year Japanese Government Bond contracts. The point of most interest to ask in relation to this cross-country derivative trading is where can this trading be the most effective? It would appear that time zones explain a large part of the trading across different exchanges but electronic trading platforms are making this less of an issue. The global market dominance of the CME for currency derivatives will probably mean that this trading will continue and the ever-increasing dominance of Euronext-LIFFE in the short-term interest rate derivative market may well mean that 3-month Euroyen TIBOR futures can continue to be a part of that market.

While Tables 4.1 and 4.2 give the products and volumes data for 2003/2004 for commodity and financial derivatives, respectively, Table 4.4 gives a breakdown of the trading in equity-based, interest rate, and currency derivative products on a value basis. As can be seen from this table, equity-based derivative products have the greatest trading value for the Asian region followed by short-term interest rate products, and then long-term interest rate products. Korea dominates the equity-based derivatives market on a volume basis while Singapore dominates in short-term interest rate derivatives and Japan dominates in long-term interest rate derivatives. The dominance in the equity-based derivatives and the long-term in-

Table 4.3

Yen-Based Financial Derivative Products and the Asia-Pacific and Major Global Derivative Exchanges on Which They Trade as at 2004. Exchanges Are the Chicago Mercantile Exchange, Euronext-LIFFE, SGX Derivatives Trading, Singapore, Osaka Securities Exchange, Tokyo International Financial Futures Exchange, and the Tokyo Stock Exchange

Contracts Traded	CME	Euronext-LIFFE	SGX	Osaka	TIFFE	TSE
Futures Products						
<i>Interest Rate</i>						
3-month Euroyen TIBOR	*	*	*		*	
3-month Euroyen LIBOR	*		*		*	
5-year Yen Swapnote					*	
10-year Yen Swapnote					*	
10-year JGB	*	*	*			*
Mini JGB			*			
<i>Equity</i>						
Nikkei 225	*		*	*		
Nikkei 225 US Dollar-based	*					
Nikkei 300				*		
TOPIX						*
Bank Equity Index						*
Electrical Appliance Equity Index						*
<i>Currency</i>						
US/Yen	*				*	
Australian Dollar/Yen	*					
Canadian Dollar/Yen	*					
Euro/Yen	*					
Swiss Franc/Yen	*					
Options Products						
<i>Interest Rate</i>						
3-month Euroyen TIBOR	*		*		*	
3-month Euroyen LIBOR	*					
10-year JGB						*
Mini JGB			*			
<i>Equity</i>						
Nikkei 225	*		*	*		
Nikkei 225 US Dollar-based	*					
Nikkei 300				*		
TOPIX						*
Individual Equity				*		
<i>Currency</i>						
US/Yen	*					

Table 4.4

Financial Derivatives Market Turnover by Value within Asia for the 2003 and 2004 Trading Years for All Exchanges that Are Members of the IOMA/IOCA (USD million)

Country	Market	Equity		STIR		LTIR		F/X		Totals	
		2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
India	BSE, National										
	SE of India	309,754	599,471							309,754	599,471
Singapore	Singapore										
	Exchange	512,302	630,218	20,275,413	10,365,798	70,187	88,193			20,857,902	11,084,209
Taiwan	TAIFEX	602,956	1,271,587		51,301		11,546			602,956	1,334,434
Hong Kong	Hong Kong										
	Exchanges	634,625	1,074,314	7,621	9,440	284	317			642,530	1,084,071
Japan*	Osaka SE, Tokyo										
	SE & TIFFE	3,018,067	4,300,755	3,589,452	6,748,333	6,812,945	9,101,063		2	13,420,464	20,150,153
Korea	Korea Exchange	22,986,463	26,542,543			958,757	711,575	75,430	104,633	24,020,650	27,358,751
Malaysia	Bursa Malaysia										
	Derivatives	4,518	12,092	31,489	37,360	3,143	627			39,150	50,079
Totals		28,068,685	34,430,980	23,903,975	17,212,232	7,845,316	9,913,321	75,430	104,635	59,893,406	61,661,168

*Notional value for Osaka SE and Tokyo SE Stock Options are not available.

Note. Notional value used—the number of contracts traded multiplied by the contracts' underlying value.

Source: Institute for Financial Markets, Futures and Options Fact Book, Monthly Vol. *Annual Report and Statistics 2004*, World Federation of Exchanges.

terest rate derivatives is locally driven, while Singapore's dominance of the short-term interest rate derivatives market is through its offering of the international Eurodollar contract. It is interesting to note, however, that trading value for this contract dropped dramatically from 2003 to 2004, driven mainly by competition from other markets globally. Trading in currency derivatives is a very minor part of financial derivatives trading for the region, as is now the case in Europe. In fact 90% of all currency derivative traded globally are traded in the United States. The low level of currency derivatives trading in Asia is driven by the fact that there is only one important free-floating currency in the region, the Japanese Yen, and by the dominant position the banks have in the OTC forward currency market.

Table 4.5 gives a breakdown of the percentage of financial derivative trading activity for the Asian countries trading these products by contract volume and contract value. Comparisons are also shown in relation to population, GDP, and GDP per capita. This table shows the importance of considering trading activity on a value basis as well as a volume basis. The extremely high volume turnover but relatively low value of the KOSPI 200 options contract traded on the Korea Futures Exchange has a major impact on comparative market size. The Korea Futures exchange accounted for an extremely high 91.38% of total financial derivative market activity in Asia for 2004 on a number of contracts traded basis. On a value basis, however, this activity level drops to 44.37%. On either basis though, the Korea Futures Exchange is still the largest financial derivatives exchange in Asia at this time.

It is also interesting to note from Table 4.5 that a country's population has little to no influence of financial derivative trading activity. Of much more significance is the combination of total GDP and GDP per capita, and just how well a particular financial derivatives market has positioned itself as with the case of Singapore.

Finally, Table 4.6 looks specifically at equity-based financial derivative activity on a value basis. As can be seen from this table, the equity index products are by far the most popular, even without the influence of the Korea Futures Exchange.

5. SINGAPORE EXCHANGE DERIVATIVES TRADING LIMITED—A CASE STUDY

Singapore Exchange Limited (SGX) was the first exchange in the Asia-Pacific region to demutualize and integrate its securities and derivatives exchange. The integration of the two exchanges happened on 1st December 1999 following the merger of two established financial institutions—the Stock Exchange of Singapore (SES) and the Singapore International Monetary Exchange (SIMEX).

Table 4.5

A Comparison of Countries within Asia in Terms of Population, GDP on a Purchasing Power Parity Basis, and Financial Derivatives Market Activity, for Those Countries with Active Financial Derivative Markets for 2003/2004

Country	Population (millions)*	GDP (ppp) USD (billion)*	GDP per Capita*	Share of Asia Financial Derivatives Market** (% of total contracts)	Share of Asia Financial Derivatives Market** (% of total value)
India	1,100.0	\$3,319.0	\$3,100	2.67	0.97
Singapore	4.4	\$120.9	\$27,800	1.00	17.98
Taiwan	22.9	\$576.2	\$25,300	2.09	2.16
Hong Kong	6.9	\$234.5	\$34,200	0.69	1.76
Japan	127.4	\$3,745.0	\$29,400	2.12	32.68
Korea	48.4	\$925.1	\$19,200	91.38	44.37
Malaysia	23.9	\$229.3	\$9,700	0.04	0.08
Total/Av. Asia	1,333.9	\$9,150.0	\$21,240	100.00	100.00

Sources:

*CIA—*The World Fact Book 2005*.

**Institute for Financial Markets, Futures and Options Fact Book, Monthly Vol. *Annual Report and Statistics 2004*, World Federation of Exchange.

Table 4.6

Stock and Equity Index Financial Derivatives Market Product Value for 2003 and 2004 for the Financial Derivatives Markets of Countries within Asia (US Dollars million)

Market	Single Stock Options		Single Stock Futures		Equity Index Options		Equity Index Futures		Main Equity Index Product
	2003	2004	2003	2004	2003	2004	2003	2004	
BSE, National SE of India	41,812	40,394	195,463	345,232	7,516	23,270	64,963	190,575	S&P CNX
Singapore Exchange					13,253	12,102	499,049	618,116	Nikkei225
TAIFEX	531	1,393			337,127	809,726	265,298	460,468	TAIFEX
Hong Kong Exchanges	14,104	21,024	60	83	147,004	188,094	473,457	865,113	Hang Seng
Osaka SE, Tokyo SE & TIFFE	N/A	N/A	0	0	1,209,520	1,722,040	1,808,546	2,578,715	Nikkei225
Korea Exchange	0	0	0	0	20,733,926	23,924,106	2,252,537	2,618,437	KOSPI200
Bursa Malaysia Derivatives							4,518	12,092	KLSE
Totals	56,447	62,811	195,523	345,315	22,228,346	26,679,338	5,368,368	7,343,516	

Note. Value data not available for single stock options on the Osaka SE.

Source: Institute for Financial Markets, Futures and Options Fact Book, Monthly Vol. *Annual Report and Statistics 2004*, World Federation of Exchange.

Singapore Exchange Derivatives Trading Limited (SGX-DT), formally SIMEX, was a pioneer in the Asian equity futures and options market. The trading of Eurodollar futures was first introduced in September 1984, and in 1986 it became the first market in Asian to list equity index futures, just ahead of Hong Kong. But what sets it apart from other exchanges is the fact that its range of products has expanded over the years to include a number of interest rate and equity-based products from other Asian countries and elsewhere.

5.1. Products

In terms of Asian equity futures and options, the products offered have expanded over the years to include Japan's Nikkei 225, Taiwan's MSCI Taiwan Index, India's S&P CNX, as well as Singapore's Straits Times Index and the MSCI Singapore Index. In terms of interest rate products, the offerings include the 3-month Eurodollar, 3-month Euroyen Tibor, 3-month Euroyen Libor, the Mini 10-year Japanese Government Bond and the 10-year Japanese Government Bond, along with the 3-month Singapore dollar interest rate and the 5-year Singapore Government Bond contracts.

As mentioned above, trading of Eurodollar futures was first introduced in September 1984. The idea behind this was to take advantage of the Singapore time zone which overlapped the European morning and North American evening hours. This allowed traders to hedge or speculate over a 24-hour period on the Eurodollar interest rate. As pointed out by Singapore Exchange Derivatives Limited, these interest rate contracts can be used in:

- Hedging loans and deposits in Singapore Dollar, US Dollar and Yen;
- Hedging Singapore Dollar, US Dollar, Yen and interest rate swaps;
- Intra-commodity, inter-commodity and inter-market trading and arbitrage.

In terms of the interest rate contracts the real successes have been the Eurodollar contract and the Euroyen Tibor contract, which traded 8.2 million and 2.5 million contracts, respectively, in 2004. Of real concern to the SGX-DT, however, was the over 50% drop in trading volume for the Eurodollar contract between 2003 and 2004. This decline was compensated for, to some degree, by the increase in volumes for the equity-based products.

In terms of the equity-based products, the Nikkei 225 and the MSCI Taiwan Index contracts have been the most successful with approximately 7.8 million and 7.0 million contracts traded in 2004. These volumes dwarf the 1.7 million trading volume for the MSCI Singapore Index in the same year. The Nikkei 225 futures contract was launched in 1986 and this contract became available for electronic trading during regular Japanese market trading hours from 1 November 2004. This has boosted trading volume substantially, particularly as transaction costs are

very competitive. Electronic trading of MSCI Taiwan Index futures also began on 12 April 2005. Singapore Exchange Derivatives Limited also trades single stock futures contracts on the blue-chip companies traded on the Singapore Stock Exchange, but trading in these contracts has been very light to date.

5.2. Global Alliances

The SGX Derivatives Trading Limited has been a partner with the Chicago Mercantile Exchange (CME) since 1984. This partnership has been the most valuable for the exchange over the years, allowing the SGX-DT to trade the Eurodollar and Euroyen contracts. It has also developed an alliance with Bloomberg allowing the exchange's risk management and investment tools to be accessed via Bloomberg terminals globally. Also in April 2002, on the commodities side, agreement was reached with the Tokyo Commodity Exchange to launch Middle Eastern Crude Oil futures on SGX.

5.3. Regulatory Issues

The SGX performs regulatory functions in issuer regulation, member supervision, market surveillance, enforcement, and risk management. For any exchange the major regulatory issues are those of disclosure, fair-trading practices, and ensuring the integrity of all trades entered into. This last role of the market regulators is probably the most important with the exchange performing daily risk monitoring and evaluation.

5.4. Future Direction

The SGX-DT is very much focused on continuing to offer derivative products for which the exchange can offer a competitive advantage, as it has done with the Eurodollar contract and Nikkei 225 contract in the past. As the financial markets of Asia continue to develop this will give SGX-DT both opportunities and more competition. Its latest innovation has been the announcement in June 2005 to develop and implement an over-the-counter ("OTC") clearing facility. The facility will initially cover energy derivatives and forward freight agreements. It is expected that this facility will reduce costs and capital requirements, encouraging more players to participate in these markets. While Singapore's time zone can continue to be used to its advantage, providing products at the right transaction cost is more likely to be the way for the SGX-DT to expand its business into the future.

6. FUTURE TRENDS IN THE ASIA-PACIFIC DERIVATIVE MARKETS

When considering future trends in derivative markets, the three areas to consider are the growth potential, the forces at work for market integration, and the future demand for the products being trading and likely new products that could come to the market. This final section of the chapter considers these three areas, with particular reference to the financial derivatives markets of Asia-Pacific.

6.1. Growth Potential in the Asia-Pacific Derivative Markets

In the case of Asia-Pacific, growth potential for the derivatives markets is still strong, particularly as the world's two most populous countries continue to liberalize and develop their financial markets. However, growth in derivatives trading year-on-year will not always be positive. For the year 2004 there was actually a drop in trading activity in Asia-Pacific as well as globally. But while derivative trading in Asia-Pacific, as elsewhere, will be affected by levels of economic growth, global competition and general market sentiment, growth in market activity overall is certain to continue in the longer-term with growth in financial derivative activity outpacing that of commodity derivatives. The commodity derivatives markets of Asia-Pacific are mainly mature markets with more moderate growth potential, but further trade liberalization could have a positive impact on trading activity.

What will be of most interest in Asia-Pacific in the shorter-term is the growth potential of financial derivatives trading in China, once that market opens there again. Financial derivatives trading in China could well surpass that of Japan on a value basis by 2010. It is also interesting to note that India accounted for less than 1% of Asian financial derivative activity on a value basis in 2004. As that economy develops, its derivative market share is certain to increase. Potentially India could grow its derivative market share in Asia-Pacific to 5% by 2010. Singapore is possibly the one country where a decline in derivative market activity is a possibility between now and 2010, given its exposure to competition in the area of its "offshore" products. However, the flair for innovation that SGX Derivatives Trading has shown in the past is certain to continue, making predictions here somewhat difficult. Overall a conservative estimate would be for financial derivatives trading in Asia-Pacific, on a value basis, to double from their current levels by 2010.

6.2. Market Integration

Market integration in Asia-Pacific can be looked at from three angles. These are “within individual countries”, “between countries within Asia-Pacific” and “between Asia-Pacific countries and the rest of the world”. While there are many efforts being made within Asia-Pacific towards closer economic ties, the countries of Asia-Pacific tend to operate more independently than those of Europe or the Americas and it is difficult to see this changing in the near future. Financial derivative market integration between the countries of Asia-Pacific is therefore unlikely at this time. On a “within country” basis most of the integration has probably already taken place. Japan and India are the only countries with more than one financial derivatives exchange and in the case of Japan each exchange has developed in own clearly defined niche. India does need to see substantial growth in its financial derivatives trading to warrant its two exchanges, but as mentioned above, this growth is potentially there. The most likely area for further integration going forward is between the countries of Asia-Pacific and the rest of the world. The relationships developed by SGX Derivatives Trading of Singapore with the Chicago Mercantile Exchange and the Tokyo International Financial Futures Exchange and Euronext LIFFE are good examples of what can be achieved to the benefit of both parties. China would do well to try to develop global alliances as it moves back into financial derivatives trading.

6.3. Product Trends

The real success story for financial derivatives products, as we have seen, has been with the equity index products. The interest in these products is certain to continue to grow, giving each country in Asia-Pacific a good core product for its derivative market. One real opportunity that exists here is for the trading of equity index products on pan-Asian indices or pan-Asian sector indices. These products could prove very successful in an investment world moving more towards sound diversification principles. Interest rate derivatives will find more favour as the debt markets of Asia-Pacific continue to develop. Currency derivatives are likely to continue to be the least popular of financial derivative products, however. This is only likely to change if the Yuan becomes a free-floating global currency, and that is still quite some time away.

APPENDIX

Information on the derivative markets of referenced in this article has been obtained from the following market websites:

www.dce.com.cn
www.shfe.com.cn
www.czce.com.cn
www.kanez.or.jp
www.c-com.or.jp
www.osamex.com/index-e.html
www.tocom.or.jp
www.tge.or.jp
www.y-com.or.jp
www.kofex.com
www.mdex.com.my
www.afet.or.th
www.sicom.com.sg
www.nmce.com
www.booe.org
www.nse-india.com
www.bseindia.com
www.sgx.com.sg
www.taifex.com.tw
www.hkex.com.hk
www.ose.or.jp
www.tiffe.or.jp
www.tse.or.jp
www.tfex.co.th
www.cme.com
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Chapter 5

MACROECONOMIC CAUSES OF A DECADE OF DEFLATION

Richard Jerram

Abstract

Poor growth, sustained deflation and zero interest rates is a unique experience for a major modern economy. The lessons from Japan are of the “how not to” variety, as policy-makers failed to deliver proactive measures to repair the banking system, while fiscal and monetary stimulus was sporadic and inadequate. Diagnosis of the problems as being structural led to an inappropriate policy response and implies the risk of continued sub-optimal measures. There might also be institutional reasons that are particular to Japan, which also mean the implications for other countries are probably limited.

1. INTRODUCTION

The experience of Japan since 1990 shows that deflation can be persistent and that it has major implications for bond yields, asset prices and overall economic performance. Various elements of the Japanese economy in the decade and half after the bursting of the 1980s bubble generate debate, but perhaps the key question is whether the experience has been unique to Japan, or whether it represents a more general risk for other developed economies. This question could be re-phrased to ask whether Japan’s weak growth and deflation was avoidable.

This chapter will argue that most of Japan’s problems reflect poor economic management and the lack of a suitable policy response to correct the distress caused once the bubble had burst. As such, most of the lessons from Japan are of the “how not to” variety. Bond market participants need to consider not just whether Japan’s experience has relevance for other markets, but also whether it

relates to the outlook for Japanese fixed income markets. The history of inappropriate policy decisions has some institutional or structural elements and it raises the prospect of further sub-optimal economic management in the future in Japan, with implications for growth and inflation. Hegel noted, “we learn from history that we do not learn from history” and it is questionable whether Japan has learned very much from the history of the past two decades.

There are three broad schools of opinion of the cause of persistent deflation and poor performance in the post-bubble era. These can be labelled “structural”, “financial system” and “demand management”. According to the structural school, Japan experienced a productivity shock in the early 1990s, to which the suitable response was structural reform to raise potential growth. This chapter will argue this is not a persuasive argument.

The financial system explanation is that the collapse of the 1980s bubble caused balance sheet distress at the banks and the corporate sector, resulting in credit constraints and mis-allocated resources. The lack of a policy response—unlike other developed economies that suffered comparable distress—resulted in a prolonged workout of the problem and poor growth.

The demand management school argues that Japan’s basic problem was a large output gap and the need for fiscal and monetary stimulus to boost growth. Premature attempts at fiscal consolidation by the Ministry of Finance (MOF) and reluctance by the Bank of Japan (BOJ) to pursue a sufficiently aggressive monetary policy condemned the economy to a decade of deflation. In effect, Japan has been unable to escape from a Keynesian liquidity trap, due to a lack of demand stimulus by policy makers.

This chapter will argue that a combination of the financial system and demand management explanations are the most persuasive. Moreover, the general belief among policy-makers that the causes of poor performance were structural resulted in policy measures that lacked relevance, and at times even exacerbated the problems. This mis-diagnosis could also be attributed to the idea that the implications from adopting solutions to financial crisis or weak demand were unacceptable in a political economy sense.

Incorrect diagnosis of the problems also leads to the risk of an inappropriate policy response now that the economy finally seems to have worked through the balance sheet distress and real estate deflation of the 1990s. Most obviously, the risk is of a prematurely aggressive tightening of monetary and fiscal policy. In the absence of an explicit inflation target, the behaviour of the BOJ should give some clues about the implicit target being pursued, but raising interest rates when prices were still falling in 2000 suggests that it is unusually low, which implies a risk of a return to deflation at some point in the future. More generally, a history of poor macroeconomic management should cause concern about future mistakes,

although tighter regulatory scrutiny and improved disclosure appear to reduce the risk of an extended period of forbearance in the event of renewed financial system distress.

This chapter will pursue the following course. First of all, we need to examine the causes of the bubble and its subsequent bursting due to the importance of understanding the background to sustained deflation, weak growth and policy inertia. This is followed by consideration of the competing views on the nature of the problems and proposed remedies. The argument is that an inappropriate policy response resulted in an unnecessarily extended period of adjustment and poor economic performance. This is followed by a consideration of whether Japan has a systemic inability to pursue optimal macroeconomic policies and what that could mean for the future development of the economy. Finally, we raise the question of the relevance of the Japanese experience for other developed economies.

2. WHERE DID IT ALL GO WRONG?

The root of Japan's problems in the 1990s and into the next decade lies in the asset price bubble of the late 1980s. The bubble stemmed from financial system deregulation combining with a period of low interest rates, and in turn it led to a period of exceptional economic growth that eventually led to an inflation overshoot. This period came to an end following an aggressive tightening of monetary policy.

In the 1980s, capital markets deregulation eroded the traditional customer base of Japanese banks. As large corporate borrowers found disintermediated sources of funding, the banks sought alternative borrowers. Unfortunately, lending practices failed to modernize in tandem with capital markets, and collateral-based loans remained the norm, with real estate being the most common form of collateral. The search for a new client base led the banks towards lending for real estate development, or to companies which were borrowing against the rising value of their real estate assets. Weak regulatory oversight, with close ties between the banks and their regulators might also have been to the detriment of prudent lending behaviour.

At the same time, in the post-Plaza Accord world, Japan was struggling to deal with the consequences of rapid currency appreciation. In 1Q85 the exchange rate averaged ¥258/US\$, but by 1Q88 it had appreciated to ¥128/US\$. This served to hold back consumer price inflation and also led to pressure on the BOJ to hold interest rates down in an attempt to combat upward pressure on the exchange rate. The BOJ cut the Official Discount Rate (ODR) from 5.0% at the end of 1985 to a low of 2.5% in February 1987 and held it there until May 1989.

Table 5.1
Breakdown of bank lending (%)

	1984	1989	1998	2004
Manufacturing	25.8	16.0	14.1	12.4
Real Estate	7.7	12.2	12.9	12.2
Other non-manu	52.6	53.7	51.3	44.3
Individuals	10.5	15.1	18.5	27.4
Local government	0.8	0.5	1.9	2.9
Overseas	2.6	2.5	1.3	0.8
Total loans (¥tr)	250.8	384.6	502.9	398.5

Source: BOJ.

The rise and fall of asset prices is captured by looking at land prices, or the behaviour of the equity market. Land prices in the six major cities trebled in the five years to the peak in September 1990, while Topix slightly more than trebled in the five years to its peak at the end of 1989. The subsequent decline saw land prices drop by three-quarters, while Topix also lost three-quarters of its value up to the trough in March 2003.

The bond market reacted in a manner consistent with other asset prices, with yields falling to a low of 2.5% in May 1987 as a result of pessimism over the economic outlook, before climbing as the inflation rate rose and the BOJ started to push up short-term interest rates. Bond yields peaked at 8.25% in September 1990, alongside land prices, and then fell fairly steadily through the 1990s. As with equity prices, a gradual recognition of the depth of the damage to growth, the weakness of the policy response and the onset of deflation, pushed bond yields down. Yields on ten-year bonds fell below 0.8% at the depth of the recession and financial crisis of 1998 before reversing, but another round of financial system concern surrounding the near-failure of Resona in 2003 took yields below 0.5%. To some extent the decline in yields tracked the slippage in inflation, but there was a drop in real yields through the period as well. The absence of index-linked bonds in the 1990s impedes analysis of the inflation expectations in the market.

As real estate prices and the stock market rose in the late 1980s, while interest rates remained low, firms found that the low cost of capital enabled them to embark on a range of investment projects with either low or uncertain returns. Business fixed investment as a proportion of GDP rose from 15.0% in 1986 to 19.3% in 1990. Similarly, a surge in housing activity and a positive wealth effect also drove strong consumer spending. The net result was that having averaged 3.6% per annum in the decade to 1986, real GDP then expanded 5.5% per annum over the followed four years.



Fig. 5.1. Real Estate Prices and Topix. Source: Japan Real Estate Institute

By 1989 strong growth was beginning to generate consumer price inflation and the BOJ progressively raised interest rates. In August 1990 the BOJ implemented its final hike in the ODR, taking the policy rate to 6.0%, even though the equity market had already fallen by one-third from its peak. There followed a hiatus of almost a year before the BOJ started to cut interest rates in July 1991, with the recession dating from February 1991.

In contrast, in the US the Federal Reserve implemented its final interest rate increase in May 2000, soon after the March 2000 peak in the stock market. The Fed started cutting rates in January 2001, only ten months after the stock market peaked, in contrast to the 19 month wait by the BOJ. The Fed was also more aggressive, taking the Fed Funds rate from 6.5% to 1.75% in the first year of easing. This 475 basis points of easing contrasted with the 225 basis point cut in the first year of the BOJ shift.

The economy weakened through 1991–1993 as first housing and then business fixed investment collapsed. By mid-1992 the government began to recognize the problem and responded with the first of several supplementary budgets that were largely focused on public works spending. The ratio of public investment to GDP rose from 6.5% in 1991 to a peak of 8.6% in 1995.

Although there is a common perception that the government kept the economy afloat through the 1990s by throwing ever-increasing resources at the public works budget, in fact 1995 marked the high water mark. The supplementary budgets were one-off allocations, so spending fell back again as projects were completed. Moreover, from the end of the decade there was a more deliberate attempt to reduce spending. As a result, by 2004, public investment had fallen to 4.5% of GDP. The government also used tax cuts to support consumer spending in the first half of the decade, with the result that consumer spending continued to grow, despite the negative wealth effect from falling asset prices.

The bursts of growth that came from fiscal stimulus were quickly reversed as spending fell back, with the most spectacular example coming in 1997. Following two years of respectable growth rates (but minimal inflation), the government embarked on a policy of aggressive fiscal tightening, by raising the consumption tax, reversing an income tax cut and taking the knife to public works spending. The economy was already close to deflation before the 1997 fiscal squeeze, as the GDP deflator was already negative, while consumer prices were marginally positive, but the ensuing recession pushed a range of price measures into negative territory, where they remained.

Having taken a risk with fiscal tightening amounting to about 2% of GDP, the economy was then hit by the effects from the Asian crisis that began in mid-1997. Failures of some major financial institutions followed and compounded the recession. Following another supplementary budget in early 1998, measures to

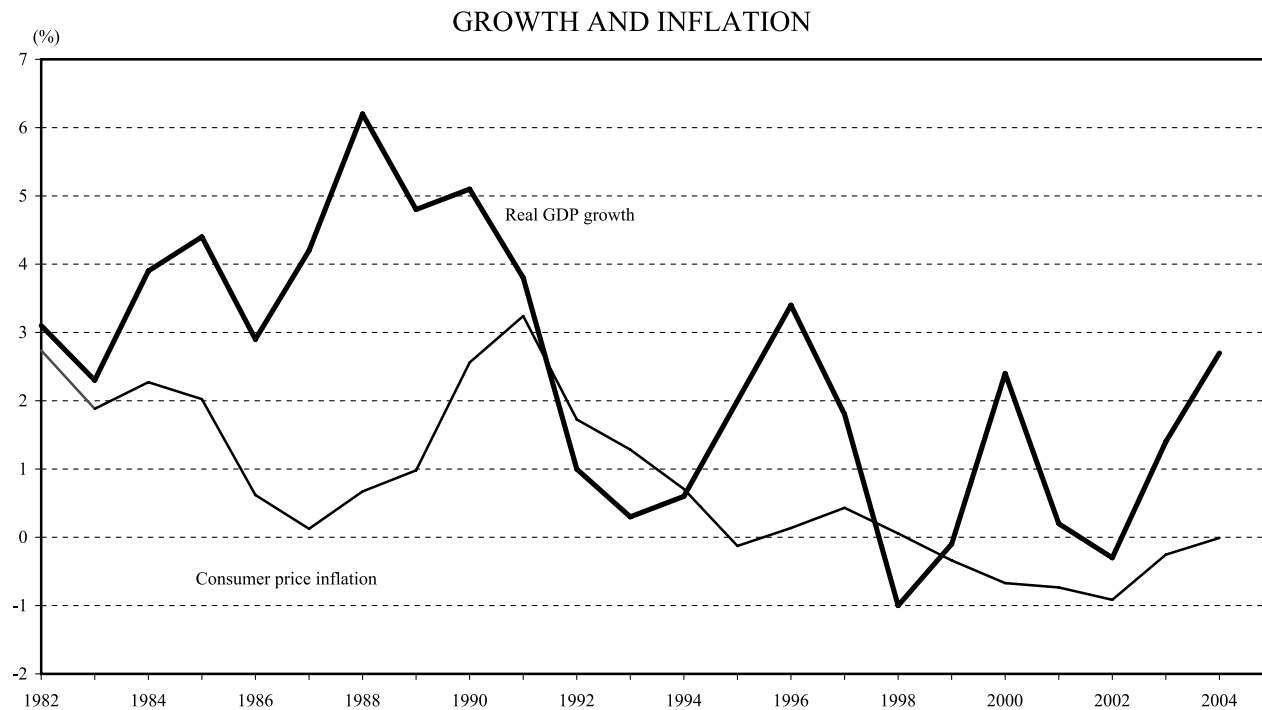


Fig. 5.2. Growth and Inflation. Source: Cabinet Office, Ministry of Internal Affairs and Communications. Inflation figures adjusted for changes in the consumption tax

stabilize the banking system, and renewed tax cuts at the end of the year the economy began to recover in 1999. An export expansion followed, driven primarily by technology-related areas, which produced a cyclical upturn similar to that of the mid-1990s.

Renewed recession from late 2000 was triggered by another convergence of shocks to demand, from falling public works spending and higher interest rates, to the more general fall in investment and exports following the bursting of the IT-bubble. By some measures this was the deepest recession of the three in the post-bubble period. The plunge in profits was the final straw for many distressed borrowers, with 2001 seeing record bankruptcies, while forcing others into a debt workout process in the following years.

Although the economy and financial system were struggling in the first half of the 1990s, deflation did not set in until the second half of the decade. The immediate post-bubble recession had seen wholesale prices and the GDP deflator turn negative, but consumer prices did not start falling until 1995 and persistent declines only started in 1998. Even then the decline was relatively slow. The worst decline over a single year was 0.9% in 2002 and the cumulative decline in the six years from 1998 to 2004 was 2.9%. Nevertheless, sustained low or negative consumer price inflation meant that by 2004 prices had fallen by 2.5% over the previous decade and so the price level was 25% below where it would have been if the BOJ had successfully been following a 2% inflation target.

The post-bubble era has become known as the “lost decade”, but in reality this probably flatters the economic performance. As discussed, it was not a decade of recession, as there were a couple of upturns, albeit truncated. However, the phrase “lost decade” is complacent, because the decade involved the destruction of both public finances and private sector wealth, as well as the cost of permanently lost output from an economy persistently operating below potential. From a low of 12.6% of GDP in 1991, the net debt to GDP ratio rose steadily through the 1990s to reach 78.4% by 2004.

Another recovery began in early 2002, this time driven primarily by exports. By late 2005 this has become the third longest post-war expansion, although the pace of growth was both moderate and slightly erratic, with growth pauses in 2Q03 and in 3Q04. Consumer price deflation lessened, with core CPI falling 0.1% YoY in 2Q05 compared to a decline of 0.9% four years earlier. Non-performing loans (NPLs) in the banking system dropped from ¥43.2tr in March 2002 down to ¥17.9tr in March 2005 and for the first time, NPLs at the major banks fell below those at the smaller, but more numerous, regional banks.

Arguing that the creation of the asset price bubble was the key policy failure is probably incorrect. As various observers noted in the US in the late 1990s, it is hard to distinguish between a bubble and a rational response to a structural

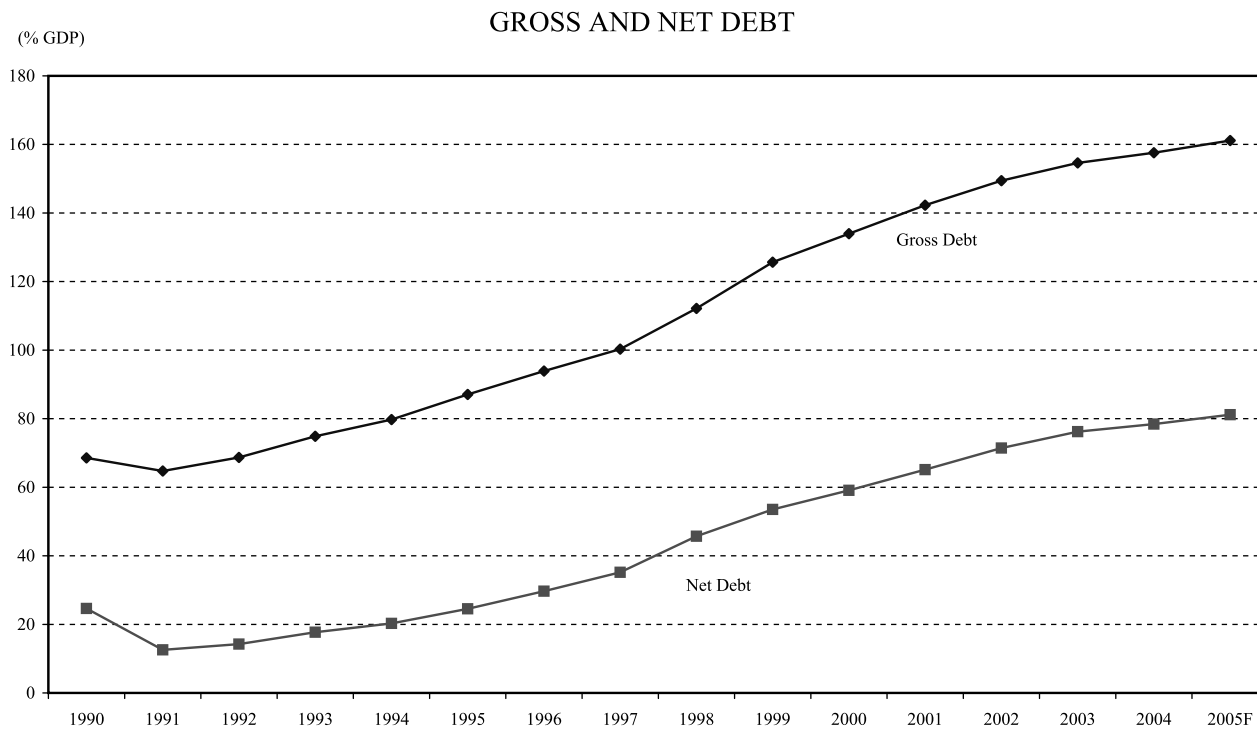


Fig. 5.3. Gross and Net Debt. Source: OECD

improvement in productivity. Moreover, other countries have suffered asset price bubbles followed by busts, or have experienced financial system distress for other reasons. The unique characteristic of the Japanese experience was the weak policy response in the wake of the bursting bubble, the growing evidence of economic and financial system distress, and eventually, deflation.

3. STRUCTURAL EXPLANATIONS OF DEFLATION

One of the mantras of Prime Minister Junichiro Koizumi, since taking office in 2001, was “no growth without reform”. Implicitly, this suggests that the root cause of slow growth and deflation in the post-bubble era was structural, rather than the result of shorter-term policy failings. However, in Koizumi’s case, reform typically had a political rather than an economic focus, even if the reform mechanism sometimes had an economic dimension. For example, cuts in public works spending seemed to be aimed at reduced the flow of pork barrel funding that typically benefited his political opponents within the ruling Liberal Democratic Party (LDP). A similar motivation appears to be behind Koizumi’s desire for reform of postal services.

The existence of structural problems that impede growth is not particularly controversial, but with differences of opinion about their relative importance. Issues such as an inefficient tax code; excessive government regulation; weak anti-monopoly rules; public sector provision of financial services; and agricultural protectionism could all be targeted for improvement. Koizumi’s limited interest in economic reform is illustrated by bilateral free trade deals that exclude agriculture, and by a failure to promote tax reform.

Moreover, Koizumi’s policies were contradictory from the start. When campaigning for the position as president of the LDP (and thus prime minister), Koizumi advanced three basic policies: deficit reduction; bad debt disposal and economic recovery through deregulation. However, subsequent fiscal tightening increased the depth of the 2001 recession and raised corporate failures, thereby deepening the bad debt problems.

If structural problems were responsible for weak growth and deflation in the post-bubble era, then we should be able to find meaningful structural change which precedes and accompanies the exit from deflation. We should also be able to find evidence of both an economic framework behind Koizumi’s reform and evidence that expectations have been influenced by policy. However a METI survey shows that firms’ medium-term GDP growth expectations of corporate Japan were the same in 2004 as they were when Koizumi took office in 2001, at 1.5%.

In the past this survey had a cyclical component, so it would have been unsurprising for growth expectations to have improved as the economy climbed out of the 2001 recession.

Koizumi was not unusual in adopting a structural approach towards rectifying poor economic performance. Chan-Lau (2001) points to Prime Minister Keizo Obuchi's Corporate Rehabilitation Law of April 2000 as a key element in the restructuring of the private sector. Obuchi's much-ridiculed successor, Yoshiro Mori, produced a package of "New Development Measures for Japan's Rebirth". In early 1997 then Prime Minister Ryutaro Hashimoto focused his administration on what he called "six reforms", which were the government, economic structure, the financial system, the social security system, education and the fiscal system. The economic objective involved restoring economic competitiveness through a five-year programme of deregulation. Over the following five years, real GDP grew by a cumulative 1.8%, or 0.4% per annum. Nominal GDP fell by a cumulative 4.5%.

Back in 1993, after the LDP temporarily lost its grip on power, Prime Minister Morihiro Hosokawa quickly unveiled a programme of 94 deregulatory changes and established an advisory panel on economic reform. The same scene can be replayed, year after year. In 1986 former Bank of Japan Governor Haruo Maekawa produced an economic reform plan that advocated switching away from the export-led model of growth. Deregulation and greater reliance on market mechanisms were to be key drivers behind the transition. The point is not whether any of these economic reform programmes succeeded or failed, in terms of either implementation or effectiveness, but that they were largely academic to the problems facing the economy in the 1990s.

At the margin, deregulation has probably made a positive contribution to growth, but the basic problem facing Japan has not been low potential growth, but that the economy has been persistently operating below potential. If low potential growth has been the problem, then it is hard to explain why deflation has proved so difficult to eradicate. If growth is averaging 1% a year, as it was through the 1990s, and deflation is steadily worsening, then the implication is that potential output growth is above 1%. Deregulation aimed at raising the potential growth rate will not close the output gap or end deflation. Moreover, a focus on structural issues diverted attention away from solutions to the real problems of a weak financial system and a shortfall in demand.

As a relative outsider in the political process, Koizumi has had more trouble implementing reforms than some of his predecessors. Although he now tends to be seen as a pro-establishment figure, Hashimoto was probably the most effective reformer of the past two decades, passing significant reforms of the administrative system and the "Big Bang" programme of financial system deregulation. The joke

at the time was that Hashimoto's Big Bang was neither large, nor very explosive, but it did produce a gradual liberalization of capital markets that, in turn, increased pressure on corporate Japan to improve returns. It also led to the development of asset markets that helped to facilitate balance sheet restructuring. This has been a gradual positive for efficiency, but it is hard to see how it was a trigger for recovery in 2002.

More formally, the structural deflation argument is based around the idea that the underlying growth rate of economy fell sharply in the 1990s. According to this argument, the main cause was a drop in the growth of productivity through the 1990s. The drop in trend growth is also related to a reduction in the length of the workweek from 44 to 40 hours, as a result of a change in government legislation.¹

This argument broadly fits with the observed behaviour of the economy, but it tends to be short of explanatory power. In particular, it is difficult to find a reason why productivity should have been so strong in the late 1980s and then collapsed in the 1990s. As discussed above, throughout the 1990s a series of governments promoted deregulation as a means of restoring economic dynamism.

Moreover, on closer examination the timing is not supportive, as the bulk of the reduction in the workweek came between 1988 and 1991, when economic growth was still exceptionally strong. Further declines in the workweek later in the 1990s appear to be a function of weak labour demand and a shift into part-time employment, rather than a government-mandated restriction of labour supply. The unemployment rate rose steadily through the decade, from 2.1% in 1991 to 5.4% in 2002, which does not suggest that restricted labour inputs were behind weak growth through the decade.

However, there is a difference between an observed decline in productivity growth and a structural decline in the underlying rate of growth. Kawamoto argues that "there is *little* or *no* evidence of a decline in the pace of technological progress during Japan's lost decade".² The low observed productivity growth is simply seen as an inevitable accompaniment to a sustained period of low growth. Total factor productivity (TFP) rises and falls with the cycle, but recessions are usually sufficiently brief that the underlying trend is still evident. Conversely, the productivity miracle that was observed in the US in the second half of the 1990s was in part due to an extended period of unusually strong growth. Kawamoto goes on to note that "if one accepts our results, the "low TFP growth puzzle" ... is not a puzzle, but a figment of cyclical errors in measuring productivity".³

¹ Hayashi and Prescott (2002).

² Kawamoto (2004, pp. 3–4). Italics in original.

³ Kawamoto (2004, p. 5).

One of the problems lies in the statistical difficulty of extracting a trend from a series that is not just showing short-term cyclical fluctuations. Statistical filters that fit a trend through a volatile series involve some form of moving averages. A long-term distortion to the economy (from financial system distress or a liquidity trap) will produce a similar result, in statistical terms, as if there had been a drop in the total factor productivity growth rate.

This problem becomes evident in measurement of the output gap—which is a calculation of how far output is from an underlying or potential level of production. As low growth persists, estimates of the output gap will be revised to show a smaller reading. For example, in December 1999 the OECD estimated the output gap in 1995 at 2.3% of GDP and in 1998 at 3.5%. By June 2005 the estimate of those measures had changed to 0.2% in both cases. The low growth rate in the intervening years had led to a downward revision to the trend growth rate, and hence a drop in the potential level of output in those years, and as a result, a lower calculation of the output gap.

Moreover, if the statistical evidence of the start of a decline in the growth rate coincides with extreme recession, a collapse in asset prices and financial system distress, then economic history would suggest the potential for a connection between the events. The behaviour of the economy in the recovery since 2002 offers a useful rebuttal of the structural argument that poor productivity was behind the low growth. As noted, if trend growth through the 1990s had adjusted down due to a productivity shock, then the output gap would have been relatively low even at the start of the recovery. Cumulative real GDP growth of 7.0% from the trough of the cycle in 1Q02 to 2Q05 should have been enough to eliminate the output gap and start to generate inflation, but consumer prices continued to fall, dropping 0.9% over the same period.

4. FINANCIAL SYSTEM EXPLANATIONS OF DEFLATION

Financial system distress intensified deflation through two opposing routes. First, capital constrained banks restricted lending to viable borrowers and prevented the development and adoption of modern lending practices. Second, banks continued to increase lending to distressed borrowers. Both actions served to damage growth.⁴

Economic damage from financial system distress is not particular to Japan and should not have come as a surprise to the authorities. There are myriad exam-

⁴ Sekine, Kobayashi and Saita (2003).

ples that illustrate the general nature of the problem.⁵ Moreover, MOF officials had conducted extensive studies into other countries' experiences with financial system distress, even in the first half of the 1990s. The unusual feature of the Japanese approach was that through forbearance it resolved the stock problem of balance sheet distress through a gradual accumulation of income flows, rather than through a one-off balance sheet adjustment. A more common approach is a rapid resolution through the use of public funds to resolve balance sheet problems.

At the heart of the problem is the bank-centred system of credit provision to all except the largest firms. As bad loans mounted and the financial system became capital constrained, banks were forced to restrict the size of their balance sheet. This led to restrictions in overall credit provisions, as bank loans fell from ¥525tr at the end of 1993 to ¥385tr by the end of 2004. As a share of GDP the ratio fell from 109% down to 76%. The constraints in lending to small and medium-sized enterprises (SMEs) were particularly problematic due to the lack of alternative sources of credit, with SMEs seeing bank borrowings fall from ¥262tr at end 1993 to ¥177tr by the end of 2004. This is a larger drop in percentage terms than the overall fall in lending, and more damaging due to the lack of alternative sources of funding available to SMEs.

Another aspect of constrained lending relates to the processes used by the banks. Lending decisions have primarily been based on the availability of collateral, which also helps to explain the stress in the system when land prices fall. Collateral-based lending means that minimal assessment of a borrower's ability to service the debt is necessary. In the event of default the lender simply takes possession of the collateral behind the loan, with the assumption being that land prices have no downside risk.⁶

The consequence of a collateral-based system is that there is a structural inefficiency through the restriction of credit to potential borrowers with an ability to repay, in a cash flow sense, but without collateral. BOJ figures show that only 2.6% of bank loans (equivalent to 2% of GDP) earn an interest rate above 4% suggesting a lack of pricing of credit risk. The potential borrowers tend to be small firms and as a result, the growth of an important dynamic part of the economy is restricted through credit constraints.⁷ This is not a direct result of the distress of the financial system, but the persistence of the inefficiency in credit provision is partly due to the inability of the banks to direct resources towards developing credit scoring systems and cash flow based lending practices, due to the need to use funds for bad debt provisioning.

⁵ Dell'Ariccia, Detragiache and Rajan (2005) provide a discussion of the issue and a list of useful references.

⁶ Hoshi and Kashyap (2001) and Aoki and Patrick (1994).

⁷ Schaefer (2004).

Banks appear to recognize this inefficiency and realize that addressing it offers a potential source of income growth, both through finding a new client base and increasing lending margins. As the health of the financial system improved in 2004, banks began developing small firm lending divisions and linking up with non-bank finance companies with a demonstrated expertise in cash flow based lending.⁸

The inverse of the problem of loans not flowing to viable borrowers is that new credits were advanced to distressed borrowers. We can measure this in the case of listed firms by looking at any new bank loans made to firms that are classed as “bankruptcy risk” by using Altman Z scores. This is shown in Figure 5.4, which aggregates the rise in loan balances of any “bankruptcy risk” firms that saw bank debt increase. The idea is that the measure captures the flow of “good money after bad” as banks throw new credits at distressed firms.

The motivation for this lending flow is that in an environment of weak regulatory oversight, the banks are able to present an accounting version of their loan book (and balance sheet) that is at odds with the economic value of the loans.⁹ In the event of bankruptcy of the borrower, the banks would be obliged to recognize the losses, which in turn could impair their ability to meet capital adequacy standards. In order to avoid this situation, the banks make new loans to weak firms to enable them to avoid bankruptcy and to continue to service their debts. One example is that loans to the real estate sector were rising through the 1990s and did not peak until 2Q99. This process came to be known as “zombie lending” as the recipients were seen as being the living dead. This is rational behaviour for distressed borrowers and distressed lenders, but it has a damaging economic impact, and Ahearne and Shinada (2004) found an inverse correlation between return on assets and loan growth in the 1990s.

Mis-allocation of productive resources follows the mis-allocation of capital. The result is that, in effect, the banks protect inefficient firms and thereby impede the process of creative destruction. As the inefficient firms fail to shrink or exit, due to the availability of new funding, it follows that the profit expectations and growth opportunities of efficient companies are constrained. Sectors with a high proportion of zombie borrowers, such as construction or retail, also had low rates of investment, labour mobility and new company formation.¹⁰ As the problem continued through the 1990s, there was a cumulative loss of productivity and, by implication, the potential for a productivity catch-up across a range of domestic sectors exists once the creative destruction process resumes.¹¹

⁸ For example, “SMFG makes Promise a partner”, *Nikkei Weekly*, 14 June 2004.

⁹ Peek and Rosengren (2003).

¹⁰ Caballero, Hoshi and Kashyap (2004).

¹¹ Ahearne and Shinada (2004).

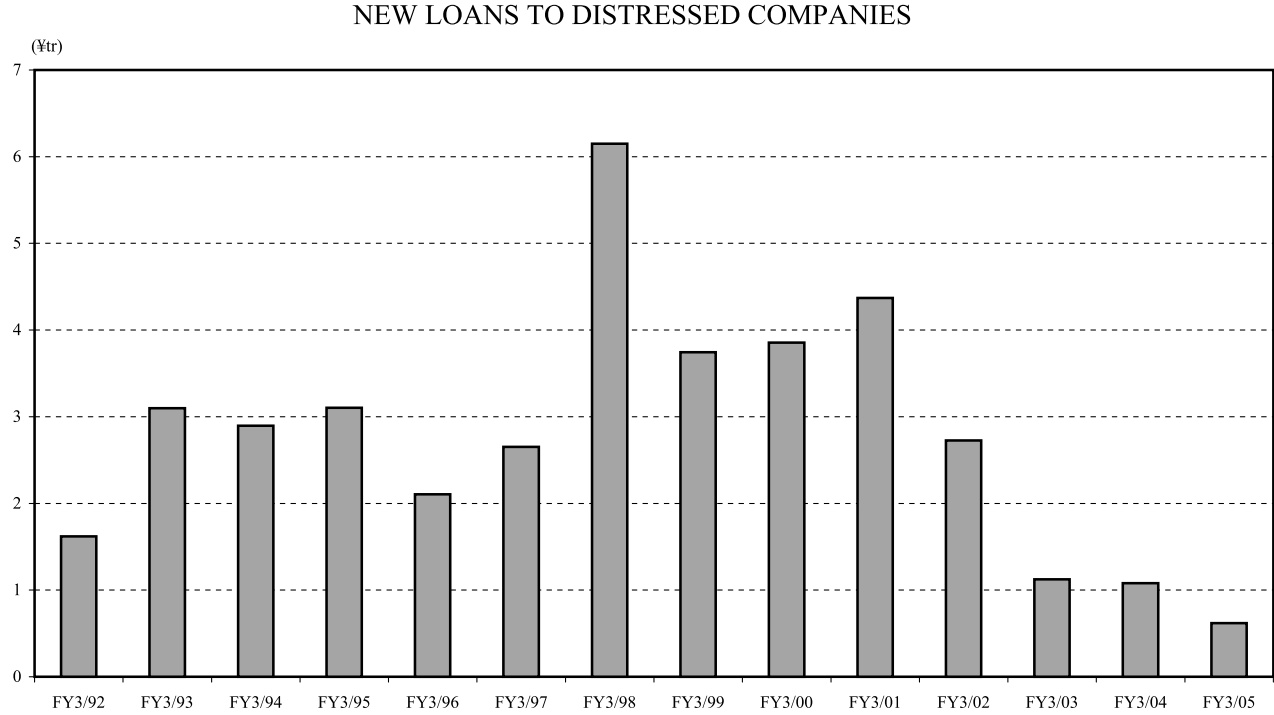


Fig. 5.4. New Loans to Distressed Companies. Source: Author’s calculations from corporate accounts

Persistent real estate price deflation was a further consequence of financial system distress. Rather than disposing of the collateral behind the impaired loans, the forbearance approach led to the assets being kept on the books of the banks because they failed to foreclose on the distressed borrowers and dispose of the assets. As a result, the real estate market failed to clear, with a large overhang of potential supply leading to expectations of further price declines. A BOJ survey shows that it was not until the bad debt problems worked through the system that real estate price expectations finally stabilized in 2004. Falling real estate prices meant that expected real returns from housing or real estate related investment were negative, despite tax incentives and low nominal interest rates, which suppressed activity.

The main counter to the argument that financial system distress was an impediment to growth is the claim that the lack of loan demand from the corporate sector accounted for the decline in bank lending. Even if correct, this would only address the credit crunch aspects of financial system distress, not the zombie lending problem. However, the reduction of overseas lending by Japanese banks (shown in Table 5.1 above) supports the idea that there was a supply problem caused by the weak capital base of the banks, as we can be confident that there was not a global shortfall in demand for credit in the 1990s.

There is also some controversy about the cause of recovery in the financial system. One interpretation is that a tougher regulatory environment under Financial Services Minister Heizo Takenaka pushed the banks to clean up their bad loan problems, and at times raise fresh capital to enable them to do so. However, he also oversaw a two-year delay to deposit insurance reform that had been scheduled for April 2003. Taking away complete government insurance of bank deposits could have led to a flight to quality by deposits and forced weaker banks into remedial action, including accepting public funds to boost their capital base.

Financial system reform under Takenaka generally involved setting achievable targets and improving disclosure of items that were not going to cause problems for the majority of the banks. One effect is to encourage continued improvement in behaviour, in particular related to capital quality. With a spectrum of quality among the major banks, a gradually tightening of the regulatory environment raised pressure on the weakest banks, some of which were forced into remedial action when they became isolated from the rest of the pack. There is a circularity to the issue, where it seems that the improving health of the financial system (due to economic recovery) allowed the FSA to tighten regulations without causing systemic disruption, while greater regulatory scrutiny contributed to a healthier system.

Looking to the future, another effect is to ensure that a repeat of a decade of concealment and forbearance is not possible. This could be described as shutting

the stable door after the horse has returned safely. Improved health of the financial system is largely a function of a favourable external economic environment, with regulatory changes to prevent recurrence of the problem.

5. DEFLATION AS A RESULT OF WEAK DEMAND

Perhaps the most orthodox explanation of weak growth and persistent deflation is that demand management policies failed to respond adequately to the deep recession that followed the boom of the late 1980s. A sufficiently aggressive stimulus to demand could have lifted the economy out of recession and ended deflation, and by boosting corporate profits and stabilizing asset prices could even have ended the financial system crisis. As the economy slid into deflation, monetary policy effectiveness was blunted by the zero limit on interest rates as well as the disruption to the transmission of policy due to financial system distress. Meanwhile the weak economy damaged public finances and evidence of wasteful publicly-funded construction projects combined to produce an aversion to fiscal stimulus. A large external surplus and trade friction with the US prevented the use of exchange rate depreciation to stimulate demand, as well as at the government for not pushing through more forceful policies.

Perhaps the main difficulty with this explanation of the 1990s problems is that it implies policy mismanagement continued for a decade. However, as discussed above, if the accepted wisdom was that structural problems were responsible for poor economic performance, then it could be that the obvious cyclical remedies were neglected. The finger of blame can be pointed at both the monetary and fiscal authorities.

The Bank of Japan was slow to cut interest rates in the aftermath of the bubble, which contributed to an unnecessary deep recession in the early 1990s and, by extension, additional pressure on the health of the financial system and the price level. By 1995 the ODR was down to 0.5% and since early 1999 the overnight call interest has been held at zero, except for a brief, ill-fated increase between August 2000 and March 2001. Difficulties in making a reliable estimate of the output gap mean that it is hard to estimate the optimal interest rate in the post-bubble period using a Taylor rule approach.¹² However, falling prices and a large output gap would imply that short-term interest rates needed to be negative through much of this period, so even zero interest rates were too high to end deflation.

However, having hit zero interest rates, the BOJ seemed content to sit back and claim that it had no room to deliver further monetary stimulus. Perhaps because of

¹² Kuttner and Posen (2004) and Billmeier (2004).

the potential relevance to the rest of the world, Japan's zero interest rate problem has generated a large flow of academic research on the subject. With the notable exception of research published by the BOJ itself, the overwhelming majority of opinion is that monetary policy options are not exhausted once interest rates hit zero.¹³ There is less agreement about the most efficient means of delivering stimulus, but there are a range of suggested policies. Ideas range from purchases of foreign assets (and yen depreciation); open market purchases; taxing money; commitments to the path of future interest rates; price level or inflation targeting; and a broader range of asset purchases by the central bank. In some cases, the boundaries between monetary and fiscal policy become blurred.

The literature also suggests that it is better to conduct monetary policy with the aim of avoiding reaching the problem of zero interest rates. At low inflation rates, the damage from an undershoot of inflation is greater than that of an overshoot, which seems to have guided the policy of the US Federal Reserve in the years since the collapse of the technology bubble of the late 1990s.

Having reached the zero interest rate boundary, the Bank of Japan's response has been concentrated on making money markets more efficient in order to improve the effectiveness of the existing policy. The BOJ has made a commitment to leave interest rates at zero until after measured inflation has turned positive, which is about the only measure which has some roots in the unorthodox policies found in the economics literature. However, the effectiveness of this commitment is undermined by the fact that the BOJ reneged on a similar promise in August 2000. Moreover, even in the absence of a commitment, the majority of economic actors would presumably assume that the BOJ would not raise interest rates before inflation was positive. In effect the BOJ is only committing not to pursue a bad policy, which is different from committing to pursue a good policy.

Fiscal policy should become more effective at zero interest rates, but has been neglected since the mid-1990s. In the first half of the decade the government used reasonably aggressive packages of spending increases and tax cuts to stimulate demand, which served to limit the depth of the recession of 1991–93 and boost the recovery in 1994. However, fiscal stimulus generally had to be dragged out of the MOF by the politicians, as the bureaucrats focused on the long-term problems for direct tax revenues and spending implied by the country's demographic profile. A steady rise in the gross debt-to-GDP ratio from 65% in 1991 to 142% a decade later led to claims that the country could not afford fiscal stimulus. These arguments were usually couched in accounting terms rather than macroeconomic ones, and tended to neglect the idea that fiscal stimulus could return the economy to equilibrium and thereby help to stabilize public finances. In addition, the pork-

¹³ For example, see Eggertsson and Woodford (2003) and Ahearne et al. (2002).

barrel nature of some of the public investment spending served to discredit the overall concept of using fiscal policy as a tool of demand management.

About the last significant round of fiscal stimulus came in 1995 as the strong yen had contributed to the recovery faltering. Since then the trend has been for fiscal tightening, albeit with temporary policy reversals. The GDP series shows public investment has halved from an annual rate of ¥45tr at the peak in 2Q96 down to ¥23tr nine years later.

6. EXPLAINING THE RECOVERY

In the context of the above three explanations of persistent weak growth and deflation, we need to examine the basis of the economic recovery that began in 2002. The sustained economic recovery since early 2002 suggests there is some merit in the demand shortfall interpretation of the problems of the 1990s. An improvement in external demand, with exports to China at the forefront, dragged corporate profitability higher, stemming the flow of new bad debts and giving the banking system the opportunity to recapitalize.

Export growth provided the initial driver for recovery. In the two years to 4Q03, overall GDP grew by a cumulative 2.7%, of which net exports contributed 1.7 percentage points (and exports alone—i.e. not netting out imports—contributed 2.8 percentage points). The early stages of the export recovery were driven by China, which accounted for half of growth in 2002 and three-quarters in 2003.

Financial markets have responded to the improvement, with the equity market up 50% from its 2003 lows by mid-2005, and bond yields rising from 0.4% to 1.2%. Within the equity market, the banking sector rose about 130% over the same period, in a reflection of growing market recognition that bad debt problems were fading.

It is hard to claim that financial system improvement played a part in the early stages of the 2002 recovery. In October 2002 the new Financial Services Minister Heizo Takenaka saw his proposals for a more aggressive approach towards the bad debt problem dramatically scaled back by resistance within the ruling coalition. In May 2003 the country's fifth largest bank was obliged to accept *de facto* nationalization, but this was about the final step in stabilizing the financial system. By 2004 it was becoming apparent that the bad debt problem was fading, but this seemed to be the result of better economic conditions improving the health of corporate borrowers, more than pro-active steps by the banks or the regulators.

In the decade to 2005 the debt-to-equity ratio of corporate Japan halved, while profit margins doubled. In part this might reflect the increased pressure on corporate Japan to improve returns that were implied by Hashimoto's Big Bang deregulation. As Figure 5.5 shows, the ability of the corporate sector to service its debt

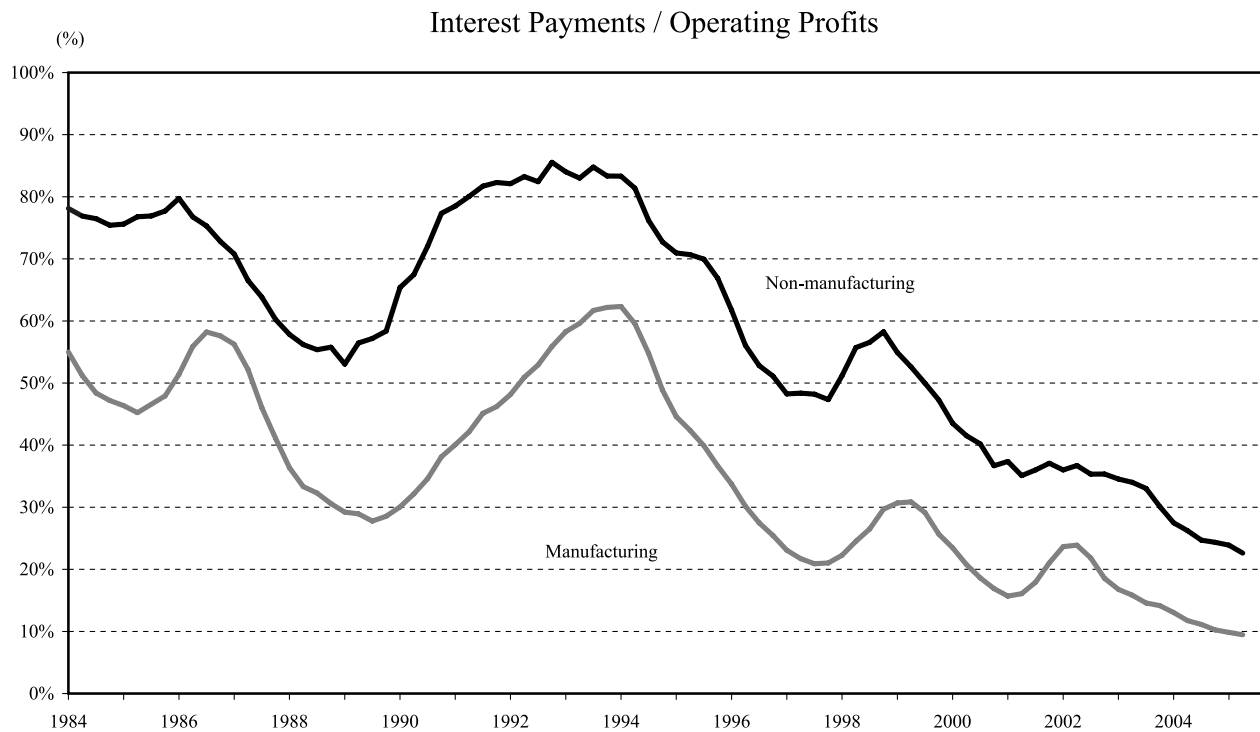


Fig. 5.5. Interest Payments/Operating Profits. Source: MOF

improved dramatically and, by implication, the quality of the banks' loan book improved. The drop in the ratio of interest payments to profits was a combination of lower interest rates, debt reduction and improved profitability. In the early 1990s around three-quarters of operating profits were needed to make interest payments on debt, but by 2005 that had dropped below 20%.

A decline in bankruptcies was a natural accompaniment to improving corporate sector profitability. By the first half of 2005 bankruptcies were running at the lowest rate in a decade and at less than half of the rate seen in the worst years of 1997–2001.

Following from the argument that a weak financial system resulted in a misdirection of loans, the recovery in the financial system gradually started to contribute to the improvement in domestic demand. Corporate restructuring accompanied healthier banks, as the borrowers were no longer able to hold the lenders captive with the threat of mutually assured destruction. Clearing out the zombie borrowers should increase productivity and raise profit expectations. Evidence of a material economic impact started to emerge in 2005 with the first full-time employment growth in a decade, led by the non-manufacturing sector. This is consistent with a resumption of creative destruction from the beginnings of a more efficient allocation of capital.

Missing from the explanation of recovery is an impact from structural reforms. At the margin, deregulation has helped to generate new businesses and new industries, while Hashimoto's Big Bang reforms might have pushed corporate Japan to raise profitability. However, there has not been a notable change in the regulatory environment that could explain the sharp economic improvement since 2002. In any case, it would be difficult to ascribe an export improvement driven by demand from China to something within the control of the Japanese authorities. As the Financial Times memorably put it "Koizumi rode to power in 2001 on the catch-phrase 'no growth without reform'. In retrospect, 'no growth without China' would have been more accurate".¹⁴ Deregulation to raise productivity growth will become more important as the economy returns to equilibrium after the distress of the 1990s, but it is hard to see it as a significant element in the improvement since 2002.

7. CAN IT HAPPEN AGAIN IN JAPAN?

The question of whether Japan could suffer a repeat of the experience of the past two decades relates to whether another bubble is possible, as well as whether it

¹⁴ *Financial Times*, 13 September 2005.

would be met by a similar lack of policy response. Arguably, the difficulty in identifying a bubble means that a recurrence is a possibility. In Japan's case the BOJ's challenge of withdrawing liquidity before it creates inflation presents an interesting risk, with the ratio of nominal GDP to monetary base falling from 12.2 times at the end of 1991 down to 4.6 times by the end of 2004. The monetary base will shrink by around one quarter when the BOJ ends the quantitative easing policy and raises interest rates, but that will still leave a lot of liquidity in the system.

One factor that might constrain any overheating of the real estate market is the development of real estate investment trusts (REITs) as an asset class since 2001. REITs offer a direct measure of yield on real estate, which can be compared to borrowing costs. In that case, negative carry (yields below borrowing costs) would be more apparent than during the late 1980s bubble, which could limit the degree of speculation.

However, bubbles do not only occur in the real estate market, as we saw in the dot.com frenzy of the late 1990s. In the event of another period of severe economic weakness, strains could easily emerge in the banking system due to its low core profitability. In the decade from 1994, core profits averaged just 0.25% of assets, compared to rates of 1–2% which is more typical in the US or UK.¹⁵ As a result, the Japanese system has a lower ability to withstand a sudden surge of losses, because they quickly eat through profits and then into the bank's capital.

If a bubble of any sort were to develop and then burst, perhaps the key change is the reduced ability of the corporate sector and financial institutions to conceal the extent of distress. Regulatory oversight of the banks has tightened considerably in recent years through the creation of the Financial Services Agency, followed by a progressive strengthening of regulations. The ability of banks to conceal non-performing loans has diminished significantly compared to five or ten years ago, while marking assets to market has penetrated corporate Japan and auditing standards have improved. As a result, the ability of a large and sustained gap to develop between the accounts presented by banks or corporates, and the real economic value of the assets on their balance sheets has diminished considerably. By implication, balance sheet problems would quickly become more evident and policy makers would find it difficult to adopt a forbearance approach, rather than providing a resolution.

The decision-making processes and the expertise of those involved gives concern about the possibility of a repeat. This has two elements. First, is the role of vested interests to generate outcomes that are detrimental to the economy as a whole. Damage caused by the nexus of political, bureaucratic and business interests is exacerbated by the near monopoly on power of the Liberal Democratic

¹⁵ Wolfson (2005).

Party (LDP) in the post-war era.¹⁶ Japan did not experience the change in government that is often associated with facing up to the scale of financial system problems, and subsequently rectifying them. Those in positions of power inside the “iron triangle” during the excesses of the 1980s had an understandable reluctance to facilitate disclosure of the scale of the bad debts in the 1990s, and political continuity allowed forbearance to persist.

Allied to this problem is the weakness of the democratic system, which continued to return the LDP to power despite the evident poor performance of the economy, as well as frequent corruption scandals. This could reflect a range of factors from the structural over-representation of the rural vote in the Diet, to the pro-establishment bias of the mainstream media, and low turnout among younger voters. Whatever the cause, the consequence is low accountability of both politicians and policy and in turn this implies that there are not significant barriers to further policy mismanagement.

The problem can be summed up as a systemic lack of accountability. For example, a proactive resolution of bad debt problems would have required an acknowledgment of the scale of the hole in banks’ balance sheets. In turn that would have led to an examination of the causes of the problem, naturally leading to recognition of policy failures, incompetence and corruption. Political and bureaucratic continuity naturally creates an incentive to avoid the implied accountability.

The second area of fault in decision-making is the quality of the analysis behind the decisions that are taken. Considering the prestige of public sector employment and the recruitment from premier universities, it might seem surprising to criticize the analytical quality of policy decisions. However, one informed argument is that “erroneous thinking prolonged the stagnation”, through a focus on supposedly structural problems and to the detriment of providing a monetary solution to deflation.¹⁷ Perhaps the highest profile example was the former BOJ Governor Masaru Hayami, who promoted the concept of “good deflation”, made frequent references to structural barriers to growth and oversaw an interest rate increase in August 2000 even though consumer prices were falling. Rather than attempting to provide a monetary solution, Hayami claimed “It is more important to spur private demand through further deregulation and tax reforms I think it’s right to say there will be no growth without reforms”.¹⁸

Specifically, the policy arena tends to be dominated by graduates of Tokyo University law faculty, which has historically been the source of the vast majority of career path recruits into the Ministry of Finance.¹⁹ Both the current governor

¹⁶ Van Wolferen (1989), Ramseyer and Rosenbluth (1993).

¹⁷ Hamada and Noguchi (2005).

¹⁸ Kyodo News, 18 February 2003.

¹⁹ Hartcher (1998), Brown (1999).

and one of the two deputy governors of the Bank of Japan are also graduates. Lack of a formal training in economics is one obvious consequence of this preference, but group thinking and reluctance to challenge decisions or expose past failures of one's seniors are associated problems.

An associated feature is the tendency to blame others and thereby fail to face up to the real nature of problems.²⁰ For example, the bubble of the late 1980s was not a result of a monetary policy mistake and general hubris, but due to the collapse of an over-valued US dollar and then American pressure to hold interest rates low. Similarly, the 1997–98 recession was the result of the Asian crisis, rather than irresponsible fiscal tightening and failures of some major financial institutions.

An example, with relation to the sustained fall in the price level, is the idea that China was exporting deflation to Japan. The Ministry of Finance seemed to embrace this idea, perhaps as a means of distracting attention from the home-grown causes of deflation that would have required a more aggressive, but politically difficult, policy response. For example in 2002, with reference to China and other east Asian economies, two senior MOF officials claimed “their combined supply capacity has been exerting downward pressure on the prices of goods in industrialized economies”.²¹ The mathematics behind the argument are not very persuasive, as goods make up only half of the CPI, while imports from China account for only about 20% of merchandise imports and 2% of domestic demand. One study has found that China has lowered global inflation by between 1/4 and 1/3 of a percentage point, which is described as “non-negligible, fairly modest”.²²

One policy risk stems from the diagnosis of Japan's problems as being related to a structurally low trend growth. If trend growth is low, then it implies the output gap is small, which in turn points to tightening monetary and fiscal policy. Uncertainties related to the measurement of trend growth should merit a deliberately reactive policy approach, so rather than tightening policy in anticipation of rising inflation, the BOJ should first confirm that inflation is accelerating before tightening.

Another risk is that if the BOJ is targeting an excessively low rate of inflation, then there is the danger that a future unanticipated demand shock could push the economy back into deflation. The BOJ has no official inflation target and has refused to be drawn on the question of whether or not it will adopt one after deflation has ended. When the BOJ raised interest rates in August 2000, consumer price inflation, excluding fresh food, was running at -0.3% YoY. In October 2000, in the wake of the monetary tightening, the BOJ noted that “the outlook for inflation as a whole is around zero or slightly negative”. The implication is that the BOJ

²⁰ Lincoln (2002).

²¹ Kuroda and Kawai (2002).

²² Kamin, Marazzi and Schindler (2004, p. 4).

had an unusually severe view of price stability as meaning no change in recorded inflation.

As a result there is the risk that a demand shock leads to renewed deflation at some point in the future, if the BOJ pursues an excessively low inflation target, while the politicians and MOF favour a structural tightening of fiscal policy. However, there is less risk that this could lead to an extended period of financial system distress.

8. CAN DEFLATION HAPPEN SOMEWHERE ELSE?

As the above discussion suggests, the Japanese post-bubble deflationary experience contains some unique elements that other developed economies are unlikely to repeat. “It takes more than a bubble to become Japan” as one economist has argued.²³ Persistent deflation in Japan was avoidable and was the result of a range of policy failures. Other economies with similarly poor regulatory standards, low quality economic management and weak political scrutiny might run the risk of a similar episode, but it is hard to find an example across the developed world.

Most developed economies have a more transparent, independent, rule-based regulatory system that would lead to a rapid exposure of serious balance sheet problems among financial institutions. This would prevent a forbearance approach from occurring in the event of a shock to balance sheets. Moreover, in systems with greater reliance on disintermediated provision of finance—most notably the US—the damage caused by bank distress should be more limited than in a bank-centric system such as Japan’s was during the bubble.

The US Federal Reserve has conducted an impressive amount of research into “the Japanese problem” over the past decade, as has the European Central Bank. Broadly speaking, there seem to be two conclusions. First, the cost of too little inflation is greater than the cost of too much inflation, so at times of deflationary risk there should be an asymmetric (pro-inflationary) bias to monetary policy. Second, even if monetary policy hits the constraint of zero interest rates, there are other policy measures available that will be effective in stimulating demand. Whether or not the Federal Reserve’s policy after the bursting of the stock market IT bubble from March 2000 was affected by its observations on Japan is unclear, but the Fed responded more aggressively than the Bank of Japan had done a decade earlier.²⁴

²³ Posen (2003).

²⁴ Harrigan and Kuttner (2004).

Deflation would seem to be more of a risk in the Euro area, where some ECB members' comments about structural barriers to growth reducing the effectiveness of monetary policy appear to echo those from the BOJ. Moreover the existence of an explicit inflation target of "close to but below" 2% might entail some deflation risks in the event of a serious demand shock. The "growth and stability pact" could also constrain the use of fiscal policy in Europe in the event that interest rates hit the zero bound. However, major Euro participants have shown a readiness to treat the pact in "flexible" manner when necessary.

We could summarize the Fed position as concluding "we don't know what will be most effective, but there are plenty of things we could try". This was the tone of a speech by Ben Bernanke in November 2002, titled "Deflation: Making Sure 'It' Doesn't Happen Here". In contrast, the BOJ position has been "we don't know if any specific policy will be effective, so we are not going to try it". Even though the current BOJ Governor Fukui is often seen as being more constructive than his predecessor, early on in his term he noted "the Bank of Japan has already exhausted its monetary tools".²⁵

It might be that the BOJ's behaviour was affected by a desire to establish credibility in the wake of its independence from April 1998, which is not a problem for countries with an established institutional structure. Until that point it was generally seen as submissive to the Ministry of Finance, which typically provided every other BOJ governor until independence. It could be that resistance to pressure from politicians and bureaucrats to monetize the bad debt problems was one factor behind the rigidity of the "nothing more can be done" approach of the BOJ. Looking back it is easy to argue that a persistent refusal to take steps suggested by academic economists and other central banks has damaged credibility, rather than built it, but this could have been a factor behind the BOJ policy caution. However, probably the worst of the BOJ's policy failures came in the first half of the 1990s, when it was slow to cut interest rates, and that preceded any dilemmas presented by independence.

In addition to the institutional reasons for a more resolute policy response to the risk of deflation in other developed economies, there is probably also a stronger history of political accountability. The idea that "it's the economy stupid" pervades the election process, with the result that a government associated with persistent deflation or poor economic management would be likely to lose power. And perhaps as a result, it is difficult to envisage the circumstances where policy makers would tolerate deflation.

²⁵ *AFX Asia*, 13 April 2003.

9. CONCLUSION

The Japanese economy experienced an unusually sharp economic slowdown in the 1990s, which led to a sustained period of deflation. The late 1980s asset price bubble and its later collapse are at the heart of the problem, but other countries have faced similar trauma without such enduring economic troubles. This chapter has argued that the causes of such an extended period of low growth and deflation are not structural, but reflect a poor policy response to weak demand and a distressed financial system.

Unfortunately, the political focus on structural problems had the result of producing a policy focus on peripheral issues such as deregulation. More seriously, it also led to active policy mistakes, such as premature fiscal and monetary tightening. These were the natural consequence of the focus on structural problems as the cause of low growth, which implicitly led to an underestimation of the size of the output gap. An incorrect diagnosis of the problems also raises the prospect of continued policy error, as do institutional problems in the process of formulating policy.

The main area of hope for Japan avoiding a recurrence of the problems of the 1990s is that financial system regulation has been steadily tightened. This should prevent another bout of forbearance, where the accounting version of banks' loan books is allowed to diverge significantly from the economic value. Low core profitability implies some risk for banking system health, but any problems would quickly become apparent, rather than remaining hidden with the damage to economic performance that this entailed.

Other developed economies seem relatively unlikely to share Japan's experience. Policy making is generally better, financial system regulation is stronger and political processes involve more accountability than Japan in the 1990s. As a result, the weak growth and deflation of the fifteen years after the bubble burst should go down as a unique and unnecessary period of history, rather than a warning of what is to come elsewhere.

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Chapter 6

THE RELATIONSHIP BETWEEN INTEREST RATES AND ECONOMIC ACTIVITY: HOW THE CONVENTIONAL LITERATURE HAS DEALT WITH THE JAPANESE EXPERIENCE

Richard A. Werner

1. INTRODUCTION

Fixed income markets fulfill many functions. One of these is the determination of market interest rates. According to most leading macroeconomic theories, interest rates in turn affect economic activity. The activity of central banks also influences fixed income markets. Clearly, the precise relationship between interest rates and economic growth is thus of importance for an understanding of the role of fixed income markets, monetary policy and the overall functioning of the economy. Since the Japanese experience has posed a number of profound challenges to the traditional theories in this area, it is of interest to consider how the literature has dealt with it.

Nominal Interest Rates

First, consider the facts. During much of the 1990s, the official discount rate (ODR) and the call rate exhibited a steady decline. The Bank of Japan lowered the official discount rate (ODR) ten times in the decade of the 1990s, beginning with the first reduction in July 1991, before which it stood at 6%. Until September 1993 it was lowered seven times, reaching a historical low of 1.75%. The ODR was further lowered to 1.0% in April 1995 and to 0.5% in September 1995. In October 1995, the uncollateralised overnight call rate was guided below the ODR for the first time (at about 0.47%). Three years later, in October 1998, the Bank of

Japan guided the call rate further down to a new record low of 0.33%. In February 1999, the call rate was even further reduced to 0.1%—what at the time began to be called a “zero interest rate policy”. After a temporary (and modest) hike in August 2000, the call rate was lowered again to 0.12% in March and 0.02% in April 2001. In September of that year, the ODR was lowered to 0.1% and the call rate to 0.003%. Similarly to the ODR, the nominal overnight call rate has with minor exceptions been in a secular decline since 1991.

Considering benchmark government bond yields with ten years to maturity to measure long-term interest rates, we find that despite brief periods of rising long-term interest rates (such as during 1994 and late 1998), the overall trend in the 1990s has also been one of steadily falling interest rates. The ten-year benchmark bond yield peaked in mid-1991 at close to 7% and fell gradually, reaching a low of 0.7% in October 1998. Having recovered to over 1% in 1999 and 2000, long-term bond yields trended down again and reached a new record low in 2003 at below 0.7%. In 1998 and 2003, the nominal bond yields thus fell below those recorded in the US during the 1940s or those recorded in Genoa in the fifteenth century; most likely they are the lowest in recorded history.

An alternative measure of nominal long-term interest rates is the long-term prime lending rate. Its trend has been even more clearly unidirectional: the average annual prime rate fell each year short of the previous year’s average. Peaking at 7.5% in 1991, by 2000 it averaged only 2.2% for all banks. It can be concluded that Japanese nominal interest rates exhibited a significant and largely secular decline during the 1990s.

Real Interest Rates

Real interest rates are commonly defined as nominal interest rates adjusted for inflation expectations. Since the latter cannot be observed directly, for our present, illustrative purposes, we substitute data on actual price changes (utilizing the consumer price index, CPI) to calculate (*ex post*) real interest rates. The real call rate annual average declined from 4.2% in 1991 to −1.3% and −0.2% in 1997 and 1998, respectively. In 1999 and 2000, it increased marginally to 0.4% and 0.8%, respectively, but remained at levels largely unprecedented internationally. On average, it recorded 1.2% over the 1990s, a historically low level by Japanese experience or by international comparison. Meanwhile, the real benchmark long-term bond yield remained stable in the first half of the 1990s, recording between 3.0% and 3.7% between 1991 and 1994. However, it fell significantly in the subsequent four years, recording a record low of 0.6% on average in 1997, followed by 0.7% in 1998. Although the average real yield rose in 1999 and 2000 (averaging 2.1% and 2.5%) it fell again to 2.1% on average in 2001. We thus can conclude that

while real interest rates have fallen less, they also declined significantly during the course of the 1990s and reached record low levels.

The fact that significant declines in nominal and real, long and short term interest rates have failed to trigger a significant economic recovery has attracted significant attention by economists during the past decade. First, the arguments centering on the unusual circumstances surrounding the near-zero interest rate policy (starting in about late 1998) are discussed. Then, the earlier, more general explanations for why interest rate reductions may not be helpful for the economy are discussed as they relate to Japan.

2. THE SPECIAL CASE: THE DEBATE SINCE LATE 1998

2.1. Main Arguments

The Liquidity Trap Argument Probably the most influential argument addressing this issue was proposed by Krugman (1998a, 1998b, 1998c). Subsequent variations on the same theme have been proposed by Bank of Japan staff, as well as Ito (2000), which will be discussed below. Choosing the definition that an “economy is in a liquidity trap if aggregate demand consistently falls short of productive capacity despite essentially zero short-term nominal interest rates”, Krugman finds Japan to be an example.¹ Krugman is careful not to imply that he is referring to Keynes’ original definition of a liquidity trap or Hicks’ interpretation (Keynes primarily referred to long-term interest rates, and his argument was not tied to any absolute nominal interest rate level, but to the expectation of capital losses incurred by investors from rising interest rates; Hicks referred to a perfectly interest-elastic money demand function and LM schedule).²

Krugman’s model assumes, among others, identical, eternally living individuals with identical time preference. There is no banking system, and hence no credit. Cash is created by open market operations by the government—there is no independent central bank.³ There is perfect information and hence no market

¹ According to this definition there would also be other examples of a liquidity trap. For instance, the US in the 1940s also recorded near-zero interest rates, though productive capacity was arguably more fully employed.

² In correspondence, Keynes explicitly disagreed with the Hicksian IS-LM interpretation of his liquidity trap (see Kregel, 2000). Consequently, in a strictly Keynesian sense the solution to a strictly Keynesian definition of a liquidity trap would be to peg long term interest rates (as was done in the US during the second world war; see Friedman, 1982). Kregel (2000), adopting Keynes’s definition, thus argues that instead of being in a liquidity trap, Japan is in an underemployment equilibrium with deficient aggregate demand.

³ One-period bonds are traded at the beginning of each period.

rationing. However, prices are sticky. Based on his definition of a liquidity trap and the above assumption, Krugman explains why interest rate reductions have failed to stimulate the economy as follows: There are exogenous expectations that future productive capacity will be lower than current productive capacity (for instance due to exogenous demographic problems). This results in deflationary expectations, such that even with nominal interest rates close to zero, real interest rates are above their full-employment equilibrium level, which is negative.⁴ Since Krugman assumes that the central bank cannot lower nominal rates below zero, and since in this model monetary policy affects the economy only via its influence on real interest rates, there is a problem—a ‘liquidity trap’. As empirical evidence in support of his argument, Krugman musters the fact that short-term interest rates approached zero, and that the broad deposit aggregate M2+CD was not growing sufficiently, despite significant increases in high powered money by the central bank.⁵ Ito (2000), as well as the IMF’s Kumar et al. (2003) follow Krugman’s analysis, although they define the liquidity trap somewhat differently. Ito and the IMF researchers use a Hicksian description of the liquidity trap, based on a horizontal LM curve.

Inflation Targeting Krugman dismisses fiscal stimulation for Ricardian equivalence reasons (which would follow from his model). He also dismisses the effectiveness of structural reforms, because they constitute a supply-side policy that does not increase demand. Instead, Krugman recommends raising inflationary expectations sufficiently to render real interest rates negative.⁶ This can be achieved by the central bank, he argues, if it can make a credible commitment that it will pursue “irresponsible monetary policy”, instead of price stability or deflation. Since Krugman argues that agents had so far considered interest rate reductions as temporary—to be reversed the moment prices start to rise—they were not effective. However, a credible commitment to a permanent increase in prices, even when inflation appears, would reverse expectations. Krugman (1998c) deduces from this the need for an inflation target. He therefore suggests legal changes to impose an inflation target on the Bank of Japan (his suggestion is 4% for 15 years), with the aim to create ‘managed inflation’ (referred to in the Japanese literature

⁴ “The problem is ... that the full-employment real interest rate is negative. And monetary policy therefore cannot get the economy to full employment unless the central bank can convince the public that the future inflation rate will be sufficiently high to permit the negative real interest rate. That’s all there is to it” (Krugman, 1998c).

⁵ High powered money rose 25% from 1994 to 1997, while M2+CD grew only 11%; as quoted by Cargill, Hutchison and Ito (2000, p. 116).

⁶ “Unless one can make a convincing case that structural reform or fiscal expansion will provide the necessary demand, the only way to expand the economy is to reduce the real interest rate; and the only way to do that is to create expectations of inflation” (Krugman, 1998c).

as *chousei infure*). Cargill, Hutchison and Ito (2000) agree with Krugman's inflation targeting proposal, and merely differ in the size of the recommended inflation target, suggesting a "1 to 3 percent target" as being sufficient for the late 1990s.

Quantitative Easing Since economists eventually recognized that nominal short-term interest rates close to zero implied the end of interest rate policy, several began to argue that the central bank might wish to consider tools other than interest rates. After all, as Bernanke (2000) reminds us, even zero interest rates are not a sign that monetary policy is stimulatory, since "low interest rates may just as well be a sign of expected deflation and monetary tightness as of monetary ease." (p. 155). Thus the unusual circumstances of near-zero interest rates have prompted economists that normally argue in favour of interest rates as the key monetary policy tool to abandon the price of money, and instead use the quantity of money as operating target. Hence those monetarist economists that had been calling for quantitative expansion earlier (and will be discussed below in Section 2.2 on the general case) were joined by the likes of Krugman (1998a), Hayashi (1998) and others, who argued that the central bank should increase the quantity of money it supplies to the economy. In Hayashi's model, as well as Krugman's subsequent models (such as Krugman, 1998c), the transmission mechanism from such quantitative policy to the economy operates via expectations: the announcement of 'quantitative easing' would prompt inflationary expectations, which would lower real interest rates and these would, in turn, act to stimulate investment and economic growth.

Structural Reform Argument There is an alternative argument why neither monetary nor fiscal policies during the 1990s were effective and why none of the above policies would stimulate growth. According to this view, represented for instance by Wilson (2000), Ikee (2001) and others, Japan's recession has been caused by supply-side problems, mainly low productivity and efficiency resulting from the Japanese economic structure. The policy advice is therefore to fundamentally reform Japan's economic structure.

2.2. Problems with Main Arguments

Structural Reform Argument The problem with the structural argument is that it is concerned with potential growth (which is a function of the quantity of factor inputs and total factor productivity). It thus fails to address the main question, namely why Japan's actual growth rate has remained below potential (as evidenced by consistently low capacity utilization in the factor markets). For a

more detailed evaluation of the structural reform argument see Werner (2004), who concludes that there is no empirical evidence in its support.

Krugman's Argument Firstly, Krugman's model operates on the basis of a number of premises that may unnecessarily restrict it. It is not obvious that a central bank cannot impose negative penalty-type interest rates, for instance, on excess reserves.⁷

Secondly, Krugman's transmission mechanism is based on interest rates and does not allow for any form of quantity effects. For instance, he argues that "no matter how much money the Bank of Japan prints *now*, it doesn't matter . . ." ⁸ This is a problem for the policy recommendations suggested by Krugman: As Bank of Japan spokesmen subsequently relished in pointing out, if there is a liquidity trap and nothing more can be done by monetary policy, how can the central bank possibly make a *credible* commitment to create inflation?⁹ Since the model describes no physical mechanism by which demand is stirred, it all depends on the credible commitment affecting expectations. But credibility is hindered by the knowledge that the central bank is merely trying to conjure up inflation expectations, while it cannot affect the economy in any physical sense. Realizing that the central bank is only trying to 'fool' agents without being able to follow up with effective deeds, the commitment will not be credible and inflation expectations cannot be stirred.

Pressed on the question what would happen, if the announcement of an inflation target failed to work, Krugman (1998c) makes a surprising retreat: Then, he concedes, there is nothing that can be done by monetary policy. "In this case the temporary fiscal jolt once again comes into its own".¹⁰ Moreover, Krugman has since argued that this worst-case scenario applies to Japan and that, therefore, monetary policy remains ineffective. In a liquidity trap, he now believes, "Additional cash pumped into the economy—added liquidity—sits idle, because there's no point in lending money out if you don't receive any reward. And monetary policy loses its effectiveness" (Krugman, 2003).¹¹

⁷ Short-term interbank rates were briefly pushed into negative territory by the Swiss central bank in early 1997. See Kugler and Rich (2001). A part of the overnight call market also temporarily recorded negative nominal interest rates in January and again in June 2003.

⁸ Krugman (1998b, p. 4).

⁹ Among others, the Bank of Japan's Okina (1999).

¹⁰ Krugman (1998c, Appendix C, p. 59).

¹¹ See also Krugman (2000), in which he concludes: "No matter how much the monetary base increases, as long as expectations are not affected it will simply be a swap of one zero-interest asset for another, with no real effects" (p. 234).

Variations on Krugman A number of other authors have come to agree with much of Krugman's analysis.¹² Some came to somewhat different policy recommendations, based on their critique of Krugman's work of 1997 and 1998. This includes the Bank of Japan, which has utilized Krugman's liquidity trap argument to support its case that the central bank had already done all that was possible to stimulate the economy. The Bank of Japan's Ueda (2001b) argues that because of the liquidity trap, monetary policies, including an inflation target, would not work due to the lack of credibility. Ueda (2001a) argues that the central bank is already operating a "weak form" of an inflation target, with little success.¹³ Any stronger version, such as naming a clear time frame, would not help, because the central bank would not be able to meet a more specific target, and hence would lose credibility, which would be counterproductive.¹⁴ In its frequent publications, the Bank of Japan has concluded from such analysis that monetary policy is ineffective, and hence other policies outside its mandate (fiscal stimulation or structural reform) should be pursued.

McKinnon (1999) takes the same stance by arguing that, due to the liquidity trap, inflationary expectations cannot be raised.¹⁵ Instead of the attempt to create expectations of inflation, he suggests stirring expectations of yen depreciation "through joint action by the Japanese and US governments" (p. 187). It is not clear, however, through what, presumably different, transmission mechanism this depreciation should be achieved within McKinnon's model, and why such a policy would, within his model, be any more credible than the policy to establish an inflation target.

Ito (2000), though in agreement with Krugman's liquidity analysis, also does not follow Krugman's initial conclusion that monetary policy remains relevant, and, like the Bank of Japan and McKinnon, argues that fiscal policy can stimulate the economy. Ito also disagrees with McKinnon's proposal to set an exchange rate target—not because the policy would be ineffective, but because of its effectiveness, as a result of which Japan's trade partners would be negatively

¹² See Itoh and Shimoi (2000), for instance, for a reiteration of Krugman's case.

¹³ The Bank of Japan stated in 1999 that it will maintain near zero interest rates until 'deflationary fears subside', and in 2001 it said that it will maintain them until there is no more deflation.

¹⁴ "With severe limitations on instruments to ease monetary policy, however, I fear that an announcement of the target date by which to achieve, say, zero percent inflation, would have either no effects on the market or be counterproductive. The market may lose confidence in a central bank announcing a hard-to-hit target" (Ueda, 2001a). It is hard to conceive, however, how investors could lose any more confidence in the ability of the Bank of Japan, than they already had at the time.

¹⁵ "The BoJ's helplessness is particularly evident in the liquidity trap with a zero interest rate and unchanged foreign exchange expectations. Thus, Dr. Okina is perfectly right in saying that simply announcing a high inflation target [as called for by Krugman] would not be credible as long as the BoJ has not the means to implement it" (McKinnon, 1999, p. 185f).

affected, and hence Japan itself.¹⁶ It is not obvious, however, that Ito's definition of a liquidity trap, based on a described dichotomy of high narrow money and low broad money growth, is meaningful. The Keynesian liquidity trap argument requires an increase in monetary aggregates that is not translated into an increase in bond holdings, and hence no fall in long-term interest rates. What the suitable actual measures of money are to represent "M" in IS-LM models remains subject to dispute. Moreover, the use of an IS-LM-based definition of the liquidity trap means that zero short-term interest rates per se cannot be used as evidence of a liquidity trap, though many observers, including Ito, appear to have done so. Instead, Ito's Hicksian definition of a liquidity trap requires a horizontal LM curve (at any interest rate), below which rates could not be lowered.

Common Problems Despite the widespread support for the liquidity trap argument by economists, the central bank, and commentators in the media, there has been little empirical support for it. Attempts at defining Japan's situation before September 1998 as a liquidity trap exist, but they failed. Weberpals (1997) tested for the existence of a liquidity trap and found no empirical support. Instead, she concludes that Japan's experience has been "unique", leaving the enigma of interest rate policy ineffectiveness unsolved.

More fundamentally, if the liquidity trap is defined as either a situation where short-term nominal interest rates are at their zero (or close-to-zero) lower bound (as Krugman and others do), or in the Hicksian (IS-LM) sense as a situation where short-term interest rates cannot be lowered any further, then by definition no liquidity trap existed during the 1990s. Strictly speaking, there could not have been a liquidity trap before 20 March 2001, since short-term nominal interest rates in earlier periods were subsequently followed by even lower rates. Even if we are willing to ignore the reductions of call rates subsequent to the September 1998 reduction to 0.1% (namely by a factor of 100 to as low as 0.001%), then also by this definition there could not have been a liquidity trap until September 1998.

Those who adopt the Hicksian IS-LM version of the liquidity trap argument are additionally handicapped by its static nature. For instance, if the demand for money was perfectly elastic with respect to interest rates, not only would subsequent falls in nominal interest rates be impossible, but also rises. However, short-

¹⁶ "Moreover, further expansion of liquidity would weaken the yen, and yen depreciation further depresses Asian economies. Yen depreciation combined with an export drive is not a solution because it would create political conflict with the United States and would not help the Asian economies recover, something that is important for a Japanese economic recovery" (Ito, 2000, p. 99).

term and long-term interest rates not only fell, but also rose during the observation period (in late 1998, interest rates on 10-year government bonds rose from 0.7% to about 2%; short-term interest rates rose in the summer of 2000, duly reflecting central bank policy).

The liquidity trap model is concerned with the comparative statics of a liquidity trap (when interest rates reached the point where they would not fall further), but not the question of how it developed. It cannot explain why *pre-trap* interest rate *reductions* throughout the 1990s have failed to stimulate the economy. That, however is the interesting question that we set out to solve. The liquidity trap model of Krugman and its variations proposed by others do not attempt to address, let alone answer this question. Similarly, the Hicksian liquidity trap model does not ask the question why the demand for money *became* perfectly elastic with respect to interest rates.

As Krugman admits, there are few solid reasons why there should be negative growth and inflation expectations. He suggests capital and credit market imperfections as a possibility, but argues that “demography seems to be the leading candidate” (1998c). In Krugman’s version, the ultimate cause are exogenous expectations of declining growth in the future. The questions of where they suddenly came from and why they seem to have hit Japan so badly appear to be at the core of understanding the problem and suggesting solutions. However, these are issues that remain outside the model. If this is so, then why are other countries that have similar or worse demography, such as Italy, not suffering from a liquidity trap?

It must be concluded that there are at least two fundamental problems with the liquidity trap argument. Firstly, by the definition of its various proponents, there actually was *no* liquidity trap throughout the 1990s in Japan (since short-term interest rates continued to fall). Secondly, the liquidity trap argument fails to address the paramount question that should concern us: why have interest rate *reductions* failed to stimulate the economy. Thus the debate about the liquidity trap is incapable of addressing, let alone solving the question that we ask in this paper, namely why interest rate reductions have not produced an economic recovery.

The liquidity trap argument elevates to a proper diagnosis of the disease and its causes, what is merely a faulty description of symptoms. Hence the prescribed therapy remains doubtful. Upon closer inspection, it implodes to a tautology, namely that short-term nominal interest rates cannot fall further, because they have fallen by as much as they can fall. We therefore turn to the literature formulating the general case for ineffectiveness of interest rate policy.

3. THE GENERAL CASE OF INTEREST RATE INEFFECTIVENESS

A number of economists have argued for at least a decade, beginning at a time when Japanese interest rates were far from zero, that mere rate reductions would be insufficient to stimulate the Japanese economy. Their arguments are based on one of the following four schools of thought, all of which have existed longer than the Japanese macroeconomic problems.

3.1. *Neutrality of Money*

Some economists argue that monetary policy is generally incapable of affecting the economy, since money is neutral. This view is in line with new classical models of the macro economy (such as Lucas, 1972) which rely on a restrictive set of assumptions.

Empirical Record There is little empirical evidence that money is indeed neutral. To the contrary, economists have for years had to grapple with the reality that money does affect the economy.¹⁷ For instance, using a different concept of causality, namely superexogeneity or ‘control causality’ (the ability to predictably affect B through one’s control of A, as proposed by Engle, Hendry and Richard (1983), and Hoover (1988), respectively) Perez (2002) found that monetary policy does matter in the case of the US. We will therefore not consider this case further. The general case against interest rate policy ineffectiveness has mainly been debated by adherents of the other three schools.

3.2. *Endogeneity of Money*

The second school of thought argues that causation does not run from money to economic activity, but in reverse order, and hence traditional monetary policy is powerless. This view is shared by Kaldor (1970) and many post-Keynesian economists who argue that the money supply is endogenous.¹⁸ Many proponents of this view also argue that the credit supply is endogenous (Moore, 1988). Concerning the role of interest rates, this school of thought argues that the “ability of the monetary authorities to control the rate of expansion of bank credit and hence the money stock in the absence of credit controls lies primarily in their ability to

¹⁷ For an overview of the key issues in the literature, see Blanchard (1990). For recent empirical work on the monetary determinants of nominal GDP in the Japanese case, see, for instance, Werner (1997).

¹⁸ For a survey of the money supply exogeneity-endogeneity debate, see Jao (1989).

determine short-term interest rates, and so the level of administered bank lending rates” (Moore, 1988, p. 232). Noting that there has been little statistically significant evidence that nominal rates are indeed negatively correlated with the quantity of money or credit, Moore argues that “the authorities’ power to control the total volume of credit expansion by this means is very slight (p. 232)”. Essentially, the endogenous money school argues that the credit market is not in equilibrium, but rationed and determined by loan demand. The loan demand is, in turn, determined by various factors inherent to the corporate sector (such as costs, taxes, inventories or other aspects of the corporate balance sheet).

Since this approach in effect absolves central banks from much responsibility (they are passive bystanders without much ability to affect the economy), it has proven to be popular among central banks. In Japan, the Bank of Japan has consistently adhered to this approach during the 1990s.¹⁹ Among economists who are not full-time staff of the Bank of Japan, Yoshikawa (1993) has been a proponent of this view.

The Bank of Japan’s Okina (1991, 1993a, 1993b) provides the most detailed description of this model, closely following Moore (1988) and others. His starting point is the observation that the central bank fulfills the double function of conducting monetary policy and acting as the lender of last resort that has to protect the stability of the financial system. Currency in circulation, at the end of 1992 accounting for 93% of high powered money, is not supplied by the central bank at its discretion, but only on demand from the public (for instance, when bank deposits are withdrawn and turned into cash for spending; banks are passive and cannot initiate this, and neither can the central bank). This demand is largely transaction-based and hence closely related to nominal consumption. Therefore, “in the short run, the central bank cannot control currency in circulation unless it drives up short-term interest rates dramatically so as to affect nominal consumption” (Okina, 1993a, at a time when methods to slow the economy were discussed). However, in its function as lender of last resort, the central bank cannot allow dramatic interest rate fluctuations, as they might endanger the stability of the financial system. Furthermore, bank reserves, the other component of high powered money, also cannot be controlled for a similar reason: As the deadline for banks to meet their reserve requirements approaches on the 15th of the month,

¹⁹ This view includes the claim that the central bank cannot influence the quantity of money or credit supplied to the economy, because otherwise financial sector stability would be endangered. Not unrelated to the rising worries about financial sector stability resulting from this stance, the central bank made a 180-degree about-turn in its policy with its 19 March 2001 decision to target indicators of the quantity of money. There is no evidence that there were obstacles to the implementation of the bond purchase targets, nor that these bond purchases increased financial sector instability. The central bank has abandoned this view, thereby delivering the empirical evidence proving it counterfactual.

the central bank may be forced to inject more money into the call market (or absorb money from it), in order to prevent 'dramatic' volatility in short-term interest rates. Hence high powered money is not under the control of the central bank and not an exogenous policy variable. It is "not the cause, but the result" (Okina, 1993b, p. 104). Having no control over the money supply, the central bank's activity is reduced to smoothing the call rate, which becomes the only viable operational target. However, the Bank of Japan is also aware of the severe limitations of this tool: Even the call rate "cannot exert substantial influence on corporate or household expenditures" (p. 87), since it has to work through other, longer-term interest rates, which in the long-run might have some influence over the money supply and domestic demand.

Yoshikawa (1993) agrees with the Bank of Japan's view that the money supply is largely endogenous to 'real shocks' in the short-run, because "central banks smooth the nominal interest rate" (p. 122), especially in the face of seasonal variations. At the same time, he points out that, like in other countries, in Japan Granger 'causality' also tends to run from money to output. His own empirical work finds that "monetary policy, represented by changes in the call rate, exerts substantial effects on real output in Japan mainly through its effect on fixed investment and imports" (p. 156). This is because "When the BoJ changes its policy stance, ... it affects real output".

The BoJ's and Yoshikawa's endogeneity appears restricted to the very short-term, seasonal movement of the economy, within a medium- to long-term setting of exogenous monetary policy. Beyond seasonality, Yoshikawa concedes that the BoJ "at times ... even actively changes the interest rate during the business cycle" (p. 157). As there is no reason why the base money targets could not be seasonally adjusted, the argument of short-run money endogeneity depends on a narrow definition of what constitutes the short-run.

Empirical Record The Japanese experience of low income elasticity of interest rates would appear to fit the endogenous money school, since in a demand-rationed credit market interest rates are not necessarily inversely correlated with economic activity. However, the overall empirical evidence in favour of this approach remains mixed, as other parts of the argument have not found convincing support: Much of the endogenous money school has focused on the problems by central banks in moving towards tighter monetary policy. As the above quote from Moore clarifies, the endogenous money school of thought assumes the absence of credit control in periods where the central bank wishes to slow the economy. However, this assumption does not apply to Japan's case of the 1980s and early 1990s. During the remainder of the 1990s, the problem was weak credit growth. Here, however, the assumption of the endogenous money school that the central bank

can only rely on interest rates to implement monetary policy is also inapplicable. Surely, the central bank remains able to *increase* the supply of money and credit to the economy, for instance by autonomously deciding to step up its purchases of private sector assets (such as bills, commercial paper, bonds, equity, real estate, etc.).

Secondly, Moore (1988) and others provide empirical evidence that credit ‘Granger-causes’ (is consistently useful in predicting) money supply. There is also some evidence that certain parts of total credit, namely bank lending to industry and commerce, especially by larger firms, may be endogenous to other factors (such as costs, inventories, taxes, or other aspects of corporate balance sheets), as Moore and Threadgold (1980, 1985) have found in the UK. However, even if these findings can be generalized, they do not imply that total credit is endogenous to such factors and that the central bank cannot autonomously increase the supply of credit.

Thirdly, there has been little empirical evidence that money or credit supply are endogenous to economic activity. To the contrary, empirical research on the relationship between money or credit aggregates and economic activity (such as nominal GDP) has more often than not yielded evidence that the monetary variable ‘Granger-causes’ economic activity (see, among others, Sims, 1972; Stock and Watson, 1989; Blanchard, 1990; Romer and Romer, 1994; Cheung and Fujii, 1999). As will be seen below, this also holds in the case of Japan in the 1990s. While such findings do not constitute ‘proof’ that causation runs from monetary variables to economic activity, it can be said that they fail to support the hypothesis of endogenous money.²⁰

Fourthly, upon closer inspection, it emerges that the Bank of Japan’s version of the endogeneity argument, despite close affinity to Moore (1988) and other post-Keynesians, does not explain why interest rate reductions failed to stimulate the economy: Although the main proponent of endogeneity, the central bank’s Okina, argues for endogeneity of the money supply to economic activity, he simultaneously argues that interest rates remain relevant. According to his theory, “... over a long time period, a reduction in interest rates, through stimulation of economic activity, increases income and raises asset prices, which can be expected to increase the appetite to hold money. Through this route, the central bank can control the money supply” (Okina, 1993b, p. 174).²¹ Since a decade should be sufficiently long for Okina’s theory to be applicable, it has failed to find empirical

²⁰ Granger causality is necessary but not sufficient to establish strong exogeneity.

²¹ In the short-run, the story is different. Here Okina recognizes that broad deposit aggregates are in no fixed link with short-term interest rates, so that “the controllability of the money supply is not something the Bank of Japan’s short-term money market operations can guarantee” (Okina, 1993b, p. 172). Indeed, there seems little the central bank can guarantee.

support. Furthermore, since according to the 'BoJ Theory' (as it was dubbed by Iwata, see below), it is interest rates, which, after all, determine economic activity and GDP growth, the Bank of Japan's theory of money endogeneity is disqualified as a potential explanation of the question that concerns us in this paper, namely why interest rate reductions have failed to do what the Bank of Japan claims they should have achieved. It is likely that this fatal claim of the 'BoJ Theory' led to its demise in 2001, as we find below.

Fifthly, the endogenous money school, like other macroeconomic theories, assumes the conventional equation of exchange to hold, where the velocity V is assumed constant (Moore, 1988, p. 305). However, the Bank of Japan's Ueda (2001b) points out that the velocity V has fallen, instead of remaining constant. In his view this is due to the liquidity trap, which, in line with Krugman, he defines as a situation of near-zero short-term interest rates. Since increases in M coincide with further declines in V , there is no impact on nominal GDP (PY). Thus Ueda argues that increases in the monetary base become practically "meaningless". As evidence he points to the frequent incidents of money market bids falling short of the total offer, reflecting a 'lack of demand' for the money the central bank is trying to supply. But he fails to provide a reason of just why velocity has been falling or why the liquidity trap came about in the first place.

In conclusion, the money endogeneity argument does not fit well with the Japanese experience of the 1990s. Moreover, it turns out that the main Japanese proponents do not actually use it to explain why interest rate reductions have failed to stimulate the economy. Instead, the Bank of Japan appears to have abandoned its long-standing endogenous money view in favour of a version of Krugman's liquidity trap argument—which in turn fails to address our main question of interest.

3.3. *The Monetarist View*

The third school of thought holds the opposite view of the second: its adherents see monetary policy as being exogenously determined by the central bank and capable of affecting output.²² Milton Friedman (1968, 1984), Poole (1982), Brunner and Meltzer (1983), McCallum (1985) and others argue that it is possible for the central bank to control high powered money exogenously in order to implement monetary policy and manipulate the economy. McCallum (1993) points out that the Bank of Japan admits that it *can* control high powered money, if it allowed greater interest rate fluctuations (while Okina failed to clarify what would constitute 'dramatic' interest rate movements). McCallum also points out that Okina's

²² This view has a long history, being associated with Milton Friedman and the older Chicago 'oral tradition'.

(1993a) justification of money endogeneity through lagged reserve requirements fails to allow for the desirable institutional change to contemporaneous reserve requirements.

In line with this view, Iwata (1992b, 1994) argues that the Bank of Japan's explanation and conduct of monetary policy—what he termed the 'BoJ Theory'—is fundamentally flawed. He argues that the central bank can exogenously manipulate the quantity of high powered money, that there is a stable relationship between high powered money and deposit aggregates (such as $M2+CD$), and in turn a stable relationship between deposit aggregates and GDP. Therefore, the central bank can manipulate economic growth by controlling high powered money. The latter is, in his view, a more appropriate measure of the stance of monetary policy than interest rates. Using this analysis, Iwata points out that the central bank tightened monetary policy too late (high powered money growth continued to rise for one and a half years after the central bank had raised interest rates for the first time in May 1989), and then failed to stimulate the economy for too long (while interest rates had been falling since 1991, the supply of high powered money contracted during much of 1992).²³ He therefore urged in 1992 that the central bank shift its operating target from interest rates to high powered money.

However, the monetarist case also suffers from some of the theoretical shortcomings of the liquidity trap argument, because the transmission mechanism of the monetary stimulus is often said to operate via expectations, just as in Krugman's (1998c) model. Allan Meltzer, a leading monetarist, for instance, argued as follows: "An announcement by the Bank of Japan and the government that the aim of policy is to prevent deflation and restore growth by providing enough money to raise asset prices would change beliefs and anticipations" (Meltzer, 1998). Thus a credible announcement by the Bank of Japan that it would provide more money would change expectations, which in turn would stimulate the economy. If, however, increases in monetary aggregates fail to trigger such expectations (because they are seen to lack credibility), then the economy would not be stimulated.²⁴

Empirical Record Subsequent to Iwata's arguments of 1992, high powered money, $M1$ and $M2+CD$ growth increased sharply. However, these increases in the money supply failed to be associated with commensurate increases in economic activity. Contrary to the monetarist framework, the monetary indicators

²³ Iwata (1992a) also argues that the Bank of Japan is responsible for the asset price bubble of the 1980s—not because of its interest rate policy, but because of its excessive supply of high powered money.

²⁴ More recently, Meltzer (2003) has argued that the transmission of monetary policy runs from an expansion of the monetary base and the money supply to a reduction in long-term interest rates, which would change the relative prices of assets and output. As will be tested more formally below, there is no evidence for the operation of such a chain of causation.

were not in a stable relationship with nominal GDP growth. This silenced many proponents of this view for many years. Many economists who noticed that M1 growth rose significantly in 1992 and 1993 predicted no further problems with Japan's economy and argued that there was no reason to fear a credit crunch or other monetary obstacles to growth.²⁵

Just like the endogenous money view, the monetarist case also rests on the assumption of a stable velocity (even though causation is said to run the opposite way). It had already been observed in many other countries that the stable relationship between money and GDP "increasingly came apart at the seams during the course of the 1980s" (Goodhart, 1989). A large body of literature has tried to grapple with this 'anomaly', but the problem remained: "recurring bouts of instability in money demand" (Goldfeld and Sichel, 1990, p. 349). Indeed, central banks in the UK and US were forced to abandon targeting monetary aggregates, since they were in no stable relationship with economic activity.²⁶ "Once viewed as a pillar of macro-economic models, it is now widely regarded as one of the weakest stones in the foundation" (Boughton, 1991).

The Japanese experience of both the 1980s and 1990s was no exception. Many publications by the Bank of Japan therefore pointed out the problem of an unstable velocity (such as Okina, 1993b). Ueda (2001b) notes that V of narrow money declined throughout the 1990s. Other, broader monetary indicators did not fare better. Apparently there was no clear-cut link between money and the economy.

The monetary transmission mechanism proposed in monetarist models such as Brunner and Meltzer's (1968) or Meltzer's (1995) operates through a rebalancing in other asset markets. However, the substantial monetary stimulation via lower interest rates and expanded monetary aggregates failed to boost asset prices significantly during the 1990s. Meltzer (2001) is thus forced to argue that the monetary stimulus was simply not strong enough. Thus, despite the record expansion in money aggregates and record low interest rates, monetary policy in fact remained 'deflationary'. However, the issue of why a decade of interest rate reductions failed to show the otherwise familiar effect is skirted.

Despite the lack of empirical support for the monetarist case, the Bank of Japan on 19 March 2001 abandoned its long-standing interest rate targeting regime and adopted a reserve target, just as the monetarists had advised almost a decade earlier. Thus the Bank of Japan became the first central bank to reintroduce explicit monetary targeting in over a decade, despite the ineffectiveness of this practice in the past. Bank reserves with the central bank were aggressively increased, rising 114% YoY in the second half of 2001. Just as the monetarists predicted, and the

²⁵ See, for instance, Morgan (1994a, 1994b).

²⁶ The Federal Reserve 'de-emphasised' M1 targeting in 1982 and abandoned formal targeting altogether in 1987 (Board of Governors of the Federal Reserve System, 1988).

BoJ's endogeneity theory denied, the central bank succeeded in meeting its reserve targets (and raised growth of high powered money), without visible volatility in short-term interest rates. However, the expected recovery in the economy failed to materialize in the following two years. The 'anomaly' of an unstable velocity persisted and undermined the monetarist argument.

When interest rates had fallen close to zero, the Bank of Japan used this as further evidence of the inapplicability of monetarist policies: Ueda (2001a) argued that with zero interest rates an injection of any quantity of money will not affect the economy, as it would merely increase the banks' idle excess reserves.

While the monetarist argument does not explicitly address the question why falling interest rates have failed to stimulate the economy, the monetarist model postulates an equilibrium in the market for money and hence a unique relationship between quantity of money variables and interest rates. Interest rates are considered endogenous to the exogenously controlled quantity of money variable(s). For monetarists, the question why interest rates have not stimulated the economy is thus equivalent to asking the question why rises in the various monetary aggregates have failed to stimulate the economy. This, however, also is a puzzle that the monetarist theory has failed to explain.

3.4. *The Credit View*

The main alternative explanation for the ineffectiveness of interest rate reductions to stimulate the economy is provided by the 'credit view'. There are three versions of it, often interrelated: The 'bank lending channel' or 'lending view', the credit rationing argument, and the 'balance sheet channel'.

3.4.1. The Lending View The pure 'lending view' argues that monetary policy actions not only affect the economy through private sector assets (the money supply), but also through private sector liabilities (borrowing and credit).²⁷ When the central bank tightens monetary policy by reducing high powered money or bank reserves, deposits decline, but banks' access to loanable funds is also reduced and hence the supply of bank loans falls (Bernanke and Blinder, 1988; Bernanke, 1993; Gertler and Gilchrist, 1993). This lending channel is said to work over and above the traditional money supply and interest-rate effects, such as represented in IS-LM analysis. As a result, proponents of this view believe that the effect of monetary policy is larger than that attributed to interest rates and the asset channel alone. Unlike the money view, the bank lending view usually distinguishes

²⁷ "In a nutshell, the credit view asserts that in addition to affecting short-term interest rates, monetary policy affects aggregate demand by affecting the availability or terms of new bank loans" (Bernanke, 1993, p. 56).

between large and small borrowers (the latter assumed to be mainly dependent on bank lending). The Japanese situation in the 1990s provides an interesting application of this theory, because it proclaims that “even under extreme conditions where either interest rates do not respond to monetary policy actions or where spending is unresponsive to changes in interest rates, monetary policy actions affect the economy because of their direct effect on bank loans” (Thornton, 1994, p. 32).

As Bernanke (1993), Gertler and Gilchrist (1993) and Kashyap and Stein (1993) argue, two necessary conditions must be satisfied for a lending channel of monetary policy to exist. Firstly, the central bank can affect the supply of bank loans, and lending is imperfectly substitutable for borrowing in the capital markets (or other forms of raising funds). For this condition to hold, bank loans and securities must be imperfectly substitutable in banks’ portfolios (otherwise banks could offset a decline in reserves due to monetary policy by increasing CDs to maintain an unchanged amount of loans in their portfolios).²⁸ The second condition for the lending view is that other intermediaries or the capital markets fail to satisfy an excess demand for loans. Thus a convincing explanation why banks (or ‘lenders’) are special must be presented, and be consistent with the empirical record.

Since bank loans are private sector liabilities, empirical researchers have often added other types of private sector liabilities to their definition of ‘lending’. Some assume that funding from banks and other, non-bank financial institutions is perfectly substitutable, while it is imperfectly substitutable with funding from capital markets (‘direct financing’ via the issuance of debt or equity). Others argue that all debt financing is perfectly substitutable (grouping bank, non-bank financial institutions and debt origination in capital markets together), while being different from (and imperfectly substitutable with) equity financing (Bayoumi, 2000; Nishimura and Kawamoto, 2003).

The contradictory claims of substitutability between different funding channels do little to enhance the intellectual appeal of the credit approach. The broader the definition of ‘lender’ becomes, the less convincing the argument that ‘lending’ is imperfectly substitutable for other forms of fund-raising and the less distinguishable the lending view becomes from the familiar representation of banks in finance textbooks as mere financial intermediaries between savers and investors

²⁸ “If banks merely satisfied their loan demand by issuing publicly held debt, there would be nothing unique about bank credit. Nothing would be fundamentally different from a bank making a loan with funds obtained from the sale of large, negotiable certificates of deposit, and a finance company making a loan with funds obtained from the sale of commercial paper. Monetary policy actions would have a similar effect on bank and other credit—there would be no separate bank lending channel for monetary policy” (Thornton, 1994, p. 39).

(see, for instance, Miller and VanHoose, 1993). Perhaps, as Thornton (1994) argues, the bank lending view comes to appreciate bank lending as a special factor just at a time when financial innovation and disintermediation renders bank lending less 'special' than it may have been in the past.

Empirical Evidence for the Lending View To establish the lending view empirically, it would have to be demonstrated that (1) central bank actions affect bank lending, even when demand does not respond to interest rate actions, because of the direct effect on lending; (2) the effect of monetary policy action is larger than the effect of the traditional monetary channel alone; (3) lending must be special and non-substitutable for other forms of fund-raising.

The evidence has not been compelling on either count. While Kashyap and Stein (1997) report significant evidence of a bank lending channel from panel data on commercial banks, especially small banks, and Bernanke and Blinder (1992) showed in a VAR model that credit aggregates fall after a rise in short-term interest rates, the results were not easily duplicated for other countries.²⁹ Although Kashyap and Stein (1997) concluded on the basis of qualitative indicators that the lending channel is more likely to be relevant in Germany than in most other countries of the European Union, VAR studies by Barran, Coudert and Mojon (1995), Guender and Moersch (1997), and Kakes, Sturm and Maier (2001), concluded that a bank lending channel is not an important transmission mechanism of monetary policy in Germany.³⁰ Furthermore, a number of studies, including Bernanke and Lown (1991), Driskoll (1994) and Haubrich (1990), fail to find support for the lending view. Only very limited support is cited by King (1986), Ramey (1993) and Hubbard (1995). Romer and Romer (1990) have shown that since about 1980, banks' ability to raise funds through CDs, securitized loans or equity issues has improved. Further, there has been little empirical support of the monitoring rationale advanced by Diamond (1984) and Fama (1985).³¹ Thornton (1994) shows that financial innovation and deregulation have increased banks' access to financial markets and reduced their dependence on funds subject to the central bank's reserve requirements. While Thornton finds a statistically significant relationship between Federal Reserve actions and both bank lending and bank deposits prior

²⁹ Bernanke and Blinder (1992) found that banks first responded by shifting securities, rather than bank loans (which are longer-term contracts), but after a lag (of two years) also reduce bank loans.

³⁰ Kakes et al. find that banks tend to shield their loan portfolios from the impact of monetary policy and instead adjust their securities portfolios.

³¹ It has been argued in theory that banks, unlike stock markets, may be able to engage in closer monitoring of companies (Sheard, 1989; Aoki, 1994; Okazaki and Okuno-Fujiwara, 1999). Interlocking shareholdings are seen in theory as a method to share risk (Sheard, 1994). However, Agarwal and Elston (2001) and Fohlin (1999) failed to find empirical support for this argument in the case of Germany.

to the early 1980s, the effect was small, and became negligible afterwards. He concludes that there was little empirical support for the lending view.

In the end, proponents of the lending view conceded: "Clearly, the Bernanke and Blinder (1988) model is a poorer description of reality than it used to be, at least in the United States" (Bernanke and Gertler, 1995, p. 41). "In summary, because of financial deregulation and innovation, the importance of the traditional bank lending channel has most likely diminished over time" (p. 42).

In Japan's case, the bank lending view is quickly dismissed, since the first condition cannot be met: bank lending failed to respond to significant rises in reserves and high powered money or reductions in interest rates throughout the 1990s.³² Several authors who have argued that they have found evidence for a lending channel in Japan turn out to have found evidence that the credit market has been rationed. That, however, is a different argument which should not be confused with the lending view.

3.4.2. The Credit Rationing Argument In order to justify why certain types of loans are special, the argument is often made that small firms are dependent on borrowing and have limited access to capital markets. Credit-rationed small firms might fail to increase plant and equipment investment by as much as they otherwise would. As Bernanke (1993), Bernanke and Blinder (1988), Gertler and Gilchrist (1993), Kashyap and Stein (1993) and Friedman and Kuttner (1993) recognize, credit rationing is neither a necessary nor a sufficient condition for the operation of a lending or credit channel of monetary policy transmission. This does not mean that credit rationing is not an important phenomenon in its own right that might explain events in Japan in the 1990s.

Jaffee and Russell (1976) and Stiglitz and Weiss (1981) showed that credit markets would be rationed even when agents are maximizing, as long as information between borrowers and lenders is asymmetric. Due to the risk of default, the lender maximizes returns by setting interest rates below the market-clearing level. This is said to provide "a firm theoretical basis" (Dimsdale, 1994, p. 35) for Keynes' (1930) argument that there is a "fringe of unsatisfied borrowers". Based on the case for credit rationing, Jaffee and Stiglitz (1990) conclude that the availability of credit is more important than the price of credit. Stiglitz and Weiss (1992) argue that with credit contracts that include both an interest rate and a collateral requirement, all types of borrowers may be rationed. As a result, interest rates charged borrowers may move either pro- or counter-cyclically.

³² In addition, Morsink and Bayoumi (2000) reported the VAR findings that "bank loans and securities respond in similar ways to monetary shocks, which is not consistent with the idea that banks use their relatively liquid assets (securities) as a temporary shock absorber and adjust their loans over the long run" (p. 155).

Empirical Evidence for Credit Rationing Evidence in support of credit rationing has been provided by Bernanke (1983), as well as Gertler and Gilchrist (1993, 1994), who considered the impact of a liquidity shortage on different types of firms (small vs. large) and found significant differences in their behaviour. Unlike large firms, small firms are more likely to cut working hours and production, as they apparently have limited access to short-term credit markets. DeYoung, Goldberg and White (1999) report that younger banks lend more to small firms than older banks. There is empirical evidence for severe credit rationing (a 'credit crunch') from Korea and Thailand (Ferri and Kang, 1998; Agenor, Aizenman and Hoffmaister, 2000). On the other hand, a study of several thousand US loan contracts by Berger and Udell (1994) did not provide evidence of significant credit rationing.

In Japan's case, most studies found that there was no evidence for a 'credit crunch' before 1997, but there has been since (Baba, 1996; Woo, 1999; Motonishi and Yoshikawa, 1999; Morsink and Bayoumi, 2000; Bayoumi, 2000).³³ Yet, even the studies that find evidence for a credit crunch during or after 1997 suffer from several defects. For instance, there are several limitations to Bayoumi's (2000) analysis: declining lending is explained by asset price movements, which remain an exogenous variable. The definition of bank lending—crucial for the argument—consists of the "sum of liabilities of the corporate sector and borrowing by the private sector" (p. 43). However, liabilities of the corporate sector include borrowing directly from the capital markets through the issuance of commercial paper, corporate bonds, etc.³⁴ Furthermore, Bayoumi warns of the limitations of VAR analysis (which applies to many of the other empirical studies), especially the assumption that the underlying responses are linear and unchanging over time. In reality, individuals "could react differently to events depending on the state of the macroeconomy, with behaviour at the tip of a cyclical upturn being rather different from that at the bottom of a downturn. Similarly, the impact of financial sector deregulation since 1980 may have altered the relationship between the corporate sector and the banking system" (p. 42).

³³ Woo (1999), examining the correlation between bank capital and lending growth, finds that there was no credit crunch before 1997, but that one occurred that year. Motonishi and Yoshikawa (1999) find that real shocks to the economy explain weak investment until 1997. Only in that year was there evidence that reduced lending, mainly to small firms, became a factor, though even then only a partial one. Morsink and Bayoumi (2000), using a VAR model, found that both monetary policy and banks' balances have been important sources of shocks, especially since 1996, and that firms and households have been unable to substitute borrowing from other sources for a shortfall in bank borrowing.

³⁴ Moreover, there appears to be an overlap between these two categories, as borrowing by the corporate sector is a subset of both the liabilities of the corporate sector and borrowing by the private sector. The procedure to deflate loans by the GDP deflator to obtain "real loans" is also debatable (as loans are also used for non-GDP transactions, but are not deflated by non-GDP prices, such as asset prices).

Meltzer (2001) rejects the rationing argument outright in the case of Japan.³⁵ “I find the argument about bank’s unwillingness to lend puzzling for two reasons. First, it does not fit well with another common argument about Japanese banking—that banks went heavily into real estate lending in the 1980s because, after deregulation, corporate borrowers greatly reduced their reliance on banks. Second, evidence from many countries suggests that loans, including very risky loans, increase in weakened financial systems with many insolvent banks. This is the familiar moral hazard argument. Both of these arguments suggest that much of the decline in lending reflected reduced demand for loans.” Yet, if weak loan demand explains the contraction in bank lending in the late 1990s, why did Japanese banks not lend more abroad? Krugman (1998c) also dismisses the credit crunch argument on the basis of the moral hazard argument.³⁶ Indeed, from 1991 to 1994 bank lending to the real estate sector increased faster than loan growth to other sectors.

Kashyap (2002), formerly a proponent of the credit view and credit rationing, appears to have accepted such arguments, as he is now criticizing Japanese banks for lending *excessively*, thereby keeping “deadbeat borrowers” in business by “routinely rolling over loans rather than pulling the plug on bankrupt firms” (p. 54). Too much lending has been detrimental, because “suppressing the normal process of creative destruction leaves all banks with fewer good borrowers to lend to. Absent good borrowers, the banks have an even greater incentive to roll over loans to deadbeat borrowers”, which, in turn, has been a “covert unemployment compensation programme” (p. 54). In other words, far from restricting demand by lending too little, banks are said to have engaged in policies that governments normally adopt to prop up demand—and they are said to have done too much of it.

Kashyap (2002), Fukao (2003) and the BIS (2002) also criticize the “strong competition from government sponsored financial institutions” (BIS, 2002, p. 133), which they argue has held bank loans back. Kashyap thus recommends to “shut down” the public banks (p. 54). The IMF (2002) even recommends that Japan reduce the number of commercial banks and public financial institutions through “exit”. If their reasoning is accurate, then banks have been willing to

³⁵ Total loans to large firms have been declining since the 1980s, which has been attributed to disintermediation and the greater possibilities for firms to raise funds from other financial intermediaries. As Meltzer (2001) points out, this makes the credit rationing argument dubious: it is known that large firms, the main customers of banks, have been leaving the banks to raise their funds directly in the markets. As a result, banks were then said to have lent excessively to small firms in the 1980s. If their lending is reduced during the 1990s, this would merely reverse the excessive lending of the 1980s. Moreover, large firms continue to be able to raise funds from elsewhere.

³⁶ He argues that banks with non-performing loans should be expected to engage in excessive lending, rather than a credit contraction, as they gamble on high-risk projects to restore solvency.

lend, but borrowers had a choice of other funding sources, and opted against the banks. Thus a large number of economists does not believe that lack of fund supply has been a key problem. However, this argument cannot be easily reconciled with the negative loan growth aggregates in the period 1998–2005.

The rapid growth of non-bank financial intermediaries and sub-prime lenders ('loan sharks') during the 1990s, as well as the historically unprecedented rise in incidents of illegal usury and the number of victims of loan sharks suggests that certain types of borrowers did face credit rationing.³⁷ However, while bank lending to some borrowers may be rationed, the main difficulty of the credit rationing argument is that such a finding in itself would be insufficient to explain why the economy failed to recover: The very increase in funding from non-bank sources is evidence that there are substitutes for bank lending. While the credit view attempts to make the macroeconomic case that monetary policy also functions through a bank lending channel (which fails in the case of Japan), the credit rationing argument is essentially a microeconomic argument. Evidence for the existence of credit rationing does not demonstrate that economic growth must be negatively affected by it. For that, it is necessary to show that fund raising and spending by others (such as large firms or the government) and through other means (such as from insurers, public banks, capital markets, borrowing from abroad, trade credit, etc.) could not compensate for the decline in fund raising by small firms (which account for only about a third of total business investment). It is not clear why the rationing of small firms has an especially large effect on the economy, quite disproportional to their size. Even in Japan, where small firms are an important part of the economy, their business investment (capital expenditure) amounts to only 24% of all capital expenditure.³⁸ Indirect financing continued to grow significantly in Japan during the 1990s. Most of all, fund raising by the Japanese government has been at record-breaking levels.

As Meltzer (1995) argues, for credit rationing to explain downturns, lending must drop by more than other fund raising in capital markets. To apply the credit rationing argument to Japan means that it must be shown that and explained why other forms of fund raising were also not available.³⁹ Meltzer (2001) argues that as an open economy with deregulated capital flows, Japanese borrowers have not

³⁷ The number of victims of loan sharks and illegal usury rose to 166,000 in the first half of 2003, already surpassing the annual high of 2002 by more than 40,000 (National Policy Agency, Tokyo).

³⁸ Ministry of Finance, Survey of Incorporated Businesses, various issues. The figure is calculated by taking the average of quarterly data over the five-year period from 1996 to 2001. Small firms are defined, as usual, as firms with paid-in capital of less than ¥100m.

³⁹ If a bank credit crunch was said to be due to bad debts at banks, then this argument does not apply to other forms of funding, such as insurers (which only accumulated bad debts of 2% of loans as of 2002, 70% of which were already reserved against).

only domestic financial markets open to them, but the world's financial resources: "Large Japanese corporations can borrow abroad, and they do. Borrowing abroad declined in the 1990s, suggesting that the decline in lending reflected reduced demand to borrow. Consumption lending by banks has been relatively small, or non-existent, during most of the postwar. Further, Japanese households have maintained a high saving rate throughout the decade. Lending gives less support to consumption spending in Japan than in the United States." There is international evidence that bank lending is substituted by other forms of lending. Calomiris, Himmelberg and Wachtel (1995) found that a reduction in bank lending is met by an increase in the extension trade credit and other forms of direct financing. Mateut, Bougheas and Mizen (2003) show that bank lending is substitutable with trade credit in the UK.⁴⁰ Kashyap (2002) also concludes that in the Japanese case the loan supply from banks, due to balance sheet problems of banks, cannot be the main problem: "There have always been international banks (and insurance companies) operating in Japan, and the number rose substantially as a result of the so-called "Big Bang" deregulation . . . These foreign firms are solvent but are choosing not to lend much in Japan. So the problem is not just that the domestic financial institutions are undercapitalized" (p. 43).

These findings on Japan mean that for the majority of the 1990s, even the credit crunch argument cannot answer the question why significant declines in interest rates failed to stimulate economic activity. No empirical paper on Japan has so far attempted to explain why the borrowing from other sources and spending by others that *did* take place to a significant extent could not make up for the decline in small firm borrowing. Thus today many observers have concluded that credit rationing by banks cannot explain Japan's predicament.

3.4.3. The Balance Sheet Channel The 'balance sheet channel', proposed by Gertler and Gilchrist (1993), argues that monetary policy actions induce changes in interest rates and prices that are propagated through their effect on borrowers' balance sheets, which in turn affect their external finance premium. The finance premium determines overall terms of credit and hence access to funding. The balance sheet channel thus recognizes the possibility of financing constraints, especially for small firms—effectively incorporating the credit rationing argument, discussed above. At the same time, it also argues that fund demand is important, as the financial position also determines the demand for funding (see Bernanke and Gertler, 1995). The chain of causation of this channel can be summarized as shown in Figure 6.1. According to the theory, the financial position depends on

⁴⁰ Mateut, Bougheas and Mizen (2003) note that trade credit had so far been neglected in the analysis of the role of bank lending in monetary policy transmission. Using evidence on 16,000 manufacturing firms, they show empirically that trade credit rises when bank lending falls.

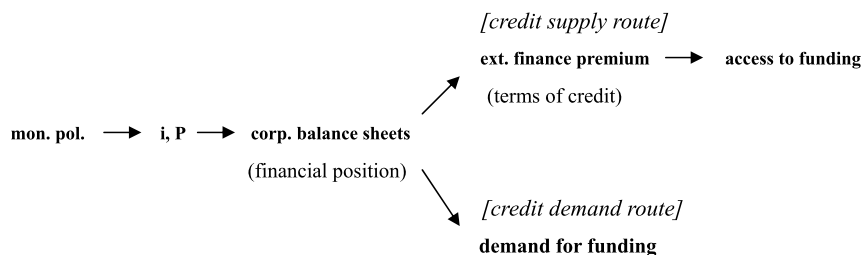


Fig. 6.1. Causation in the Balance Sheet Channel.

net worth, which may also be important as collateral. Unlike the lending channel, this channel is operative “even if the central bank has no direct leverage over the flow of bank credit” (Gertler and Gilchrist, 1993, p. 7). However, it requires monetary policy to affect corporate balance sheets, such that higher interest rates will worsen the balance sheet position of potential borrowers (Bernanke and Gertler, 1995).

There are two problems. The balance sheet channel needs to demonstrate that stimulative monetary policy (such as lower interest rates) actually affects corporate balance sheets positively. Secondly, just like the credit rationing argument, it must demonstrate that any negative impact of the balance sheet situation of certain borrowers (in practice, small firms) on their fund-raising cannot be compensated for through fund-raising by other borrowers. Since small firms account for only a small part of total investment, there is the need for some kind of multiplier of the effect (what Bernanke and Gertler call an ‘accelerator’). Kiyotaki and Moore (1997) offer a theoretical model of the ‘balance sheet channel’ with such an accelerator. They show that in a world in which lenders require collateral for loans, demand shocks may have prolonged real effects amplified by the effects of asset price fluctuations. The value of real assets as collateral constrains the supply of loans (the credit market is rationed). If a shock increases the supply of loans, this stimulates the firms’ investments and raises the value of real assets owned by the firm. Thus when debt has to be secured by collateral, such as land, and the collateral is also an input in the production function, a small negative shock reducing the net worth of credit-constrained firms leads them to reduce their investment in land. Land prices and output fall. This further reduces the capacity of firms to obtain loans, which will additionally reduce land prices and output. With their model, Kiyotaki and Moore have demonstrated that the conditions under which a disproportionate effect of small firm balance sheets can be shown are non-trivial and not immediately recognizable as realistic. The model relies on a number of behavioural relationships and assumptions, including exogenous pro-

ductivity shocks, sticky prices, direct control of credit by the central bank and imperfect substitutability of loans and bonds for both banks and borrowers.

Empirical Evidence on the Balance Sheet Channel The primary argument of the balance sheet channel, that higher interest rates slow the economy via this channel, and hence that lower interest rates stimulate it, is not consistent with the Japanese experience of the 1990s. Despite significant reductions in interest rates, balance sheets apparently failed to improve sufficiently to stimulate a lasting recovery. Secondly, the credit rationing argument has not been adequate in explaining the Japanese economic performance, as discussed above. Thirdly, there is no evidence that the fall in land prices in Japan during the 1990s was triggered by firms selling their land assets, as Kiyotaki and Moore postulate.⁴¹ It appears that land prices declined before any substantial selling of land by firms occurred.

More direct empirical tests of the balance sheet channel have been inconclusive. In this context, Ogawa's (2000) VAR estimates are notable, as he reports empirical support for the balance sheet channel, working through land used as collateral by firms.⁴² However, land prices themselves are postulated to depend on monetary policy: "Monetary policy affects the interest rate, which in turn influences the asset price" (p. 388). Yet, lower interest rates during the 1990s did not raise asset prices. That land data correlate well with bank borrowing was already well documented, and does not in itself constitute unambiguous evidence of a balance sheet channel.⁴³ Thus Ogawa has merely replaced one puzzle (why interest rates have failed to boost the economy) with another (why interest rates have failed to boost land prices). As a result, the main question of concern, why interest rate reductions have failed to stimulate a lasting recovery in Japan in the 1990s, remains unanswered. There are other problems with his study.⁴⁴

In summary, the empirical record of the bank lending, credit rationing or balance sheet channel theories, what we have termed as the 'credit view', has remained patchy at best. Most of all, they do not fit the Japanese experience well.

⁴¹ In addition, the firms that are credit rationed tend to possess little land; the main landholders are larger firms.

⁴² Ogawa actually frames his findings in terms of the 'credit view', arguing that if a fall in land prices reduces bank lending irrespective of the call rate, this is supportive of the 'credit view'. In fact, it contradicts the argument of the credit view, and should instead be construed as support for the balance sheet view.

⁴³ See Ito and Iwaisako (1996), Werner (1997) and earlier work by Werner cited in Werner (2005).

⁴⁴ For instance, Ogawa, citing Ueda (1993), uses the call rate as the sole measure of monetary policy, since he believes that the call rate has been "the direct target of monetary policy by the BoJ for most of the postwar period" (p. 394). There is little evidence to support this assumption. Window guidance bank credit controls were the main tool of monetary policy by the BoJ for most of the postwar period (Werner, 2005).

As a result, we saw that leading experts, including the IMF, now assume that bank financing is perfectly substitutable with other funding sources. This is why Hoshi and Kashyap (2000) argue that, while the bank credit channel is impaired, accelerated structural reforms in the financial sector should facilitate fund raising. Thus they advise Japan to “fully open the markets now, most importantly to foreign financial institutions”. The IMF and others argue that both public and private banks should be closed down in Japan. However, until a satisfactory explanation is found, caution towards policy advocacy based on theories not backed by the empirical record seems advisable.

4. CONCLUSION AND OUTLOOK FOR FURTHER RESEARCH

Our wide and eclectic survey found many attempts by researchers from various schools of thought to deal with the question why interest rate reductions failed to stimulate a lasting recovery in Japan during the 1990s. However, it must be concluded that none of the studies has found a satisfactory answer to the question, which is clearly supported by empirical evidence. This finding means that the Japanese macroeconomic experience of the 1990s poses a fundamental challenge to established economic theories. Since Japan is the second-largest economy in the world, this challenge should serve as stimulus to economists to either refine their theories further, or tread on alternative paths.

Despite this finding, this survey has also made clear that many interesting insights have been gained from the wide literature surrounding Japan. Indeed, the differing schools appeared to have a different ‘comparative advantage’ in successfully highlighting specific important aspects of the monetary process in Japan. Proponents of one school will recognize that other schools of thought have some insights to offer. This suggests that perhaps future research should take the direction of eclectic models that attempt to combine different aspects and insights from different schools of thought.

The idea that credit rationing and the problems of the Japanese banking system have been a core issue hampering a sustained recovery has become more widely accepted. However, as was seen, even this argument needs further refinement. It has remained limited to microeconomic aspects and a clearer link to macroeconomic models remains to be established. This is an issue of importance for monetary economics in general: while models with micro-foundations or microeconomic models of market failure have made advances, much work remains to be done to link them into macroeconomic theories. It would appear that the role of banks as the bridge between the micro and macroeconomic levels is crucial.

This has been recognized by a number of researchers. Thus further work seems needed on the question of why banks might be 'special'.

More generally, this survey has demonstrated that much time and effort can be spent on ultimately fruitless work in building models. One important lesson of how the economics community has dealt with the Japanese challenge should therefore be in terms of scientific research methodology. So far, deductive models, based on axioms and assumptions, have been dominant. This may be fruitful and has serious advantages, if the models created in this way continue to be congruent with reality. Their weakness is that once discrepancies between theory and reality ('anomalies') are observed, the deductive approach does not offer any guidance on how a model should be adapted. Thus a process of trial and error follows, whereby different researchers propose different deductive models, and then test whether they fare better empirically. This, however, is not the most efficient research methodology to advance knowledge.

Perhaps this is an area where economists can learn much from natural scientists. In their disciplines, it has become well established that the inductive research methodology provides for a more effective approach in identifying theories and models of how the world works. According to the inductive method the researcher, as objective bystander, maintains no prejudice concerning the relevant theory, but instead first begins by analyzing the data, in the search for patterns that fit the data. Based on a sound understanding of empirical reality, attempts are then made to formulate models that may fit the data (thus involving some deductive work, which is, however, subordinated to the empirical facts). According to this approach, any restrictive assumption must be justified, as the fundamental principle of parsimony indicates that a simpler model (with fewer restrictive assumptions) is preferable to a more complex model.

Over the past several decades, more and more economists have left the world of perfect information, complete markets, flexible prices, perfect competition, and no transaction costs, and experimented with models that relax one or another of these restrictive assumptions. It is clear, that many fruitful insights have been produced by such work. However, the scientific process cannot be said to have been systematic or clearly guided by empirical reality. This growing body of knowledge has therefore remained scattered and without unifying theory.

According to the inductive methodology, the researcher would start from a world with none of these assumptions and build models and theories that can explain much, with little. Any serious observation of reality would yield the finding that information imperfections and how agents deal with them are a central aspect of economic activity—thus must not be assumed away. This has implications for the common assumption of equilibrium: Walrasian market clearing is only obtained under the assumption of perfect information. The inductive methodology

therefore will quickly yield models that may challenge long-held beliefs of economists. Yet, if the aim is to work objectively, then economists should not shy away from developing quite different theories, as long as such theories do a better job at describing reality. Thus it may be hoped that more work following the inductive methodology will be done, which may well yield the unifying paradigm that can account for as much as conventional theories can, but also for the ‘anomalies’ observed in Japan.

A first step in this direction was made by Werner (2005): here a parsimonious, dependent on fewer assumptions, is suggested which is grounded in empirical reality. It can explain what traditional approaches could explain, but also the numerous ‘anomalies’ that traditional models could not account for. This includes the puzzle of the ineffectiveness of interest rate reductions in Japan.

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Credit Risk Measures and Management

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Chapter 7

DYNAMIC EQUILIBRIUM CORRECTION MODELLING OF YEN EUROBOND CREDIT SPREADS

Seppo Pynnönen, Warren P. Hogan and Jonathan A. Batten

Abstract

Understanding the long term relationship between the yields of risky and riskless bonds is a critical task for portfolio managers and policy makers. This study specifies an equilibrium correction model of the credit spreads between Japanese Government bonds (JGBs) and Japanese yen Eurobonds with high quality credit ratings. The empirical results indicate that the corporate bond yields are cointegrated with the otherwise equivalent JGB yields, with the spread defining the cointegration relation. In addition the results indicate that the equilibrium correction term is highly statistically significant in modelling credit spread changes. Another important factor is the risk-free interest rate with the negative sign, while there is little evidence of the contribution of the asset return to the behaviour of spreads.

1. INTRODUCTION

The Japanese Government bond (JGB) market remains one of the worlds largest domestic bond markets. However, in international markets the yen also finds considerable favour with issuers owing to its low coupon and deep foreign exchange and derivative markets. While the Japanese Government generally does not issue securities in Eurobond, or foreign bond markets, Japanese yen denominated Eurobond issues by the Japanese corporate sector are now the second largest in terms of new issues and outstandings after U.S. dollars, and comprise nearly US\$508 billion worth of outstanding bonds.

Given the scale and scope of these offshore yen denominated securities markets there are potential opportunities for the diversification of funding and risk

management by corporations and international portfolio managers. However, in spite of the importance of these markets, little is known of the behaviour of yen denominated securities generally, and there are few empirical studies that investigate the relation between risky and riskless yen bonds, or specifically, the credit spreads which represent the difference in yield between two different risk classes of security. In earlier work Batten, Hogan and Pynnönen (2003) investigate the time series relationships of yen Eurobond spread changes to the most important factors predicted by Longstaff and Schwartz (1995) model and some additional factors found important mainly in U.S. markets. Pynnönen, Hogan and Batten (2006) further investigate the credit spread behavior, and find that the equilibrium correction, time varying volatility and correlation factors are potentially important factors affecting the spread behaviour.

Recent theoretical developments on the valuation of risky debt proposed by Longstaff and Schwartz (1995), Das and Tufano (1996) and Duffie and Singleton (1999), predict a negative correlation between changes in default-free interest rates, the return on risky assets and changes in credit spreads. The empirical evidence in support of this relation is mixed. Originally, in U.S. bond markets Longstaff and Schwartz (1995) found evidence of a negative relation for both interest rate and asset changes. A weak but significant negative relation between changes in credit spreads and interest rates was also found by Duffee (1998) and Collin-Dufresne, Goldstein and Martin (2001), while Neal, Rolph and Morris (2000) identified a negative short-term relationship with credit spreads that reversed to positive in the long-run. For non-U.S. markets, Kamin and von Kleist (1999) find little evidence of a short-term relation between industrial country interest rates and emerging market bond spreads.

While the above papers focus directly on modelling under the restriction of a static equilibrium relation, the potential cross dynamics between the series demands a far more versatile approach. The strategy in this paper is to begin with an unrestricted setup using vector autoregression (VAR) of the important factors found in the earlier papers, particularly in Batten, Hogan and Pynnönen (2003), and to then identify the cross-dynamics between the series. The obvious advantage of this approach is that we can identify the important feedback relations between the credit spread and a set of established factors. This allows us to determine the time lags in the adjustment process to the equilibrium once shocks have driven the yields out of the equilibrium.

There is surprisingly considerable evidence that credit spreads, measured in terms of yield differences over the corresponding government bonds, per se are non-stationary (for example Pedrosa and Roll, 1998; Mansi and Maxwell, 2000). In spite of these, it is fairly implausible that the yields could wander away from one other, without any boundary, in the long run. This was also confirmed in

Pynnönen, Hogan and Batten (2006), where strong evidence was found for stationarity of the AA and AAA rated yen Eurobonds.

Pynnönen, Hogan and Batten (2006) find that the most important factor driving credit spread changes, as predicted by Longstaff and Schwartz (1995), is the change in the risk-free rate. On the other hand the second important factor, firm asset return, implied by the Longstaff–Schwartz model was not found to be statistically significant. The reason for this may be due to the fact that general stock market index returns, which are usually utilized as proxies for the firm asset returns, do not properly reflect the true default situation, particularly when restricted to high credit rated AA and AAA rated bonds. The other important factor found in Pynnönen, Hogan and Batten (2006) was the change in the slope of the term structure of Japanese government bonds, proxied by the change in the yield spread of 20 year and 2 year bonds. Two other factors of importance were the cointegration relation (spread) and conditional volatility of the spread changes.

The importance of the conditional volatility as an explanatory variable in the mean equation of credit spread changes is again a factor that is not predicted by the theoretical model of Longstaff and Schwartz (1995). However, Engle, Lilien and Robins (1987) find that the excess yield of the long bond depends on the conditional variance rather than being a constant. The empirical results of Pynnönen, Hogan and Batten (2006) indicate also that the conditional volatility is potentially an important factor in determining the credit spreads. The Longstaff and Schwartz (1995) model as well as other models predict that asset return volatility, as an indicator of riskiness, should be an important determinant of the credit spread. In the case of the corporate bonds it may well be that the conditional volatility of the credit spread replaces the more traditional stock return volatility as a surrogate for measuring the volatility of the firm.

Utilizing these earlier findings we focus on dynamic modelling of the equilibrium relation of credit spreads on the yen Eurobonds. The paper contributes to the existing literature by specifying the dynamic structure of the equilibrium correction and identifying the important feedback links between the factors related to the credit spreads. The next section describes the methodology employed; the empirical results are then presented, while the final section offers conclusions drawn from these empirical findings.

2. METHODOLOGY

Following Pynnönen, Hogan and Batten (2006), let $\mathbf{y}_t = (y_{1,t}, \dots, y_{p,t})'$ denote a column vector of p time series, where the prime denotes transposition. Denote

the general unstructured vector auto regression VAR model as

$$\mathbf{y}_t = \Phi_1 \mathbf{y}_{t-1} + \cdots + \Phi_k \mathbf{y}_{t-k} + \mathbf{B} \mathbf{x}_t + \boldsymbol{\varepsilon}_t = \Phi(L) \mathbf{y}_t + \mathbf{B} \mathbf{x}_t + \boldsymbol{\varepsilon}_t, \quad (1)$$

where Φ_j , $j = 1, \dots, k$, are $p \times p$ autoregressive coefficient matrices, $\Phi(L) = \Phi_1 L + \Phi_2 L^2 + \cdots + \Phi_k L^k$ is the matrix lag-polynomial, $\mathbf{x}_t$ is a q -vector of predetermined variables including the intercept term unit vector, possible trends, seasonal terms etc., $\mathbf{B}$ is the $p \times q$ coefficient matrix of the predetermined variables, and $\boldsymbol{\varepsilon}_t$ is independent normally distributed error term with contemporaneous correlation matrix Σ . Partition $\mathbf{y}_t = (\mathbf{y}'_{1,t}, \mathbf{y}'_{2,t})'$ such that $\mathbf{y}_{1,t}$ is a p_1 -vector ($1 \leq p_1 \leq p$) where the series are $I(1)$, and $\mathbf{y}_{2,t}$ is a $p - p_1$ vector of stationary variables. Using the partition, write (1) as

$$\begin{pmatrix} \mathbf{y}_{1,t} \\ \mathbf{y}_{2,t} \end{pmatrix} = \begin{pmatrix} \Phi_{11,1} & \Phi_{12,1} \\ \Phi_{21,1} & \Phi_{22,1} \end{pmatrix} \begin{pmatrix} \mathbf{y}_{1,t-1} \\ \mathbf{y}_{2,t-1} \end{pmatrix} + \cdots + \begin{pmatrix} \Phi_{11,k} & \Phi_{12,k} \\ \Phi_{21,k} & \Phi_{22,k} \end{pmatrix} \begin{pmatrix} \mathbf{y}_{1,t-k} \\ \mathbf{y}_{2,t-k} \end{pmatrix} + \begin{pmatrix} \mathbf{B}_1 \\ \mathbf{B}_2 \end{pmatrix} \mathbf{x}_t + \begin{pmatrix} \boldsymbol{\varepsilon}_{1,t} \\ \boldsymbol{\varepsilon}_{2,t} \end{pmatrix}. \quad (2)$$

Because all the $I(1)$ variables are in $\mathbf{y}_1$, the equilibrium correction (EqCM) representation (called also error correction model, ECM) can be written as

$$\begin{aligned} \Delta \mathbf{y}_{1,t} = & \Pi_1 \mathbf{y}_{1,t-1} + \Gamma_{1,1} \Delta \mathbf{y}_{1,t-1} + \cdots + \Gamma_{1,k-1} \Delta \mathbf{y}_{1,t-k+1} + \Phi_{12,1} \mathbf{y}_{2,t-1} + \cdots \\ & + \Phi_{12,k} \mathbf{y}_{2,t-k} + \mathbf{B}_1 \mathbf{x}_t + \boldsymbol{\varepsilon}_{1,t} \end{aligned} \quad (3a)$$

and

$$\begin{aligned} \mathbf{y}_{2,t} = & \Pi_2 \mathbf{y}_{1,t-1} + \Gamma_{2,1} \Delta \mathbf{y}_{1,t-1} + \cdots + \Gamma_{2,k-1} \Delta \mathbf{y}_{1,t-k+1} + \Phi_{22,1} \mathbf{y}_{2,t-1} + \cdots \\ & + \Phi_{22,k} \mathbf{y}_{2,t-k} + \mathbf{B}_2 \mathbf{x}_t + \boldsymbol{\varepsilon}_{2,t}, \end{aligned} \quad (3b)$$

where $\Pi_1 = \Phi_{11,1} + \cdots + \Phi_{11,k} - \mathbf{I}$, $\Gamma_{1,j} = -\sum_{l=j+1}^k \Phi_{11,l}$, $\Pi_2 = \Phi_{21,1} + \cdots + \Phi_{21,k}$, and $\Gamma_{2,j} = -\sum_{l=j+1}^k \Phi_{21,l}$, $j = 1, \dots, k-1$.

Now if the $I(1)$ series are cointegrated, the rank, r , of Π_1 is less than p_1 , and there exists a decomposition $\Pi_1 = \boldsymbol{\alpha}_1 \boldsymbol{\beta}'_1$, where $\boldsymbol{\alpha}_1$ and $\boldsymbol{\beta}_1$ are $p_1 \times r$ full rank matrices. The matrix $\boldsymbol{\beta}_1$ contains the stationary cointegration relationships of the $I(1)$ variables, and $\boldsymbol{\alpha}_1$ contains the short term adjustment coefficients of discrepancies from the long term equilibrium determined by the cointegration vectors. In order for (3b) to be balanced in the sense that both sides of the equation are stationary there must exist a $(p - p_1) \times k$ matrix $\boldsymbol{\alpha}_2$ (that can be a zero matrix) such

that $\Pi_2 = \alpha_2 \beta_1'$. Thus α_2 contains the response coefficients of the stationary variables to the discrepancies of the $I(1)$ variables from the long term equilibrium. In most cases this, however, may not be plausible.

In any case, the important point here is that the rank of Π_1 determines the dimension of the cointegration space. As discussed above, for identification of the equilibrium relationships, it may, however, be important to include besides the predetermined terms given in $\mathbf{x}_t$, also the stationary variables of the system in to the cointegration relation. Johansen (1995, pp. 80–84) is a useful reference for discussion concerning the deterministic terms in the cointegration relation. Here, we focus purely on the inclusion of the endogenous stationary series. This approach is particularly useful when the cointegration vectors can be fixed on the basis of prior knowledge, like in our case of credit spreads. For the purpose write the whole system (2) in the EqCM form

$$\Delta \mathbf{y}_t = \alpha \beta' \mathbf{y}_{t-1} + \Gamma_1 \Delta \mathbf{y}_{t-1} + \cdots + \Gamma_{k-1} \Delta \mathbf{y}_{t-k+1} + \mathbf{B} \mathbf{x}_t + \boldsymbol{\varepsilon}_t, \quad (4)$$

where α and β are $p \times r$ matrices with $\beta' = (\beta_1', \beta_2')$ of rank r , the cointegration rank of the system. The matrix β_1 determines the cointegration relations of the $I(1)$ variables in the system and β_2 includes the coefficients of the stationary variables in the equilibrium relations. In principle the contribution of the stationary variables into the equilibrium relation can be estimated at the same time with the $I(1)$ variables. Nevertheless, it is more efficient to solve the problem separately first for the integrated variables and to then map the cointegration VAR into $I(0)$ space, where one can purely deal with stationary variables and utilize the advanced estimation techniques developed therein.

Let $\mathbf{c}_t = \beta' \mathbf{y}_t = \beta_1' \mathbf{y}_{1,t} + \beta_2' \mathbf{y}_{2,t}$, then denoting $\mathbf{s}_t = \beta_1' \mathbf{y}_{1,t}$, multiplying Eq. (4) from the left by β' , and collecting terms, we get

$$\Delta \mathbf{s}_t = \tilde{\alpha} \mathbf{s}_{t-1} - \beta_2' \Delta \mathbf{y}_{2,t} + \boldsymbol{\eta} \mathbf{y}_{2,t-1} + \tilde{\Gamma}_1 \Delta \mathbf{y}_{t-1} + \cdots + \tilde{\Gamma}_{k-1} \Delta \mathbf{y}_{t-k+1} + \tilde{\mathbf{B}} \mathbf{x}_t + \mathbf{v}_t, \quad (5)$$

where $\tilde{\alpha} = \beta' \alpha$, $\tilde{\Gamma}_i = \beta' \Gamma_i$, $\tilde{\mathbf{B}} = \beta' \mathbf{B}$, and $\mathbf{v}_t = \beta' \boldsymbol{\varepsilon}_t$. Regarding parameter $\boldsymbol{\eta}$, it should be noted that, because $\mathbf{y}_{2,t}$ is stationary, it is possible that in the same manner as the exogenous variables, $\mathbf{x}_t$, the stationary variables may play in two roles; in the one hand inside and in the other hand outside the equilibrium correction relation. What we have in Eq. (5) is the aggregate contribution. If $\mathbf{y}_{2,t}$ solely contributes to the equilibrium correction term, then coefficient vector $\boldsymbol{\eta}$ obeys the restriction $\boldsymbol{\eta} = \tilde{\alpha} \beta_2'$. Consequently the portion $\tilde{\boldsymbol{\eta}} = \boldsymbol{\eta} - \tilde{\alpha} \beta_2'$ reflects the contribution of $\mathbf{y}_2$ to the spread, outside of the equilibrium correction relation.

In order to further interpret the parameters, let us assume that the system is in the equilibrium, which is achieved when the variables are at their means. That

is, when $E(\mathbf{s}_t) = \boldsymbol{\mu}_s$, $E(\mathbf{y}_t) = \boldsymbol{\mu}_y$, $E(\mathbf{x}_t) = \boldsymbol{\mu}_x$ and $E(\mathbf{v}_t) = 0$, in which case $E(\Delta \mathbf{s}_{1,t}) = 0$, $E(\Delta \mathbf{y}_{2,t}) = 0$ and $E(\Delta \mathbf{y}_{t-j}) = 0$ for all $j = 1, \dots, k-1$, and we get $0 = \tilde{\boldsymbol{\alpha}} \boldsymbol{\mu}_s + \boldsymbol{\eta} \boldsymbol{\mu}_{y_2} + \tilde{\mathbf{B}} \boldsymbol{\mu}_x$. Now $\tilde{\boldsymbol{\alpha}}$ is a $p_1 \times p_1$ full rank matrix so that the inverse exists, the average of the equilibrium relation determined as

$$\boldsymbol{\mu}_s = -\tilde{\boldsymbol{\alpha}}^{-1}(\boldsymbol{\eta} \boldsymbol{\mu}_{y_2} + \tilde{\mathbf{B}} \boldsymbol{\mu}_x). \quad (6)$$

Thus, particularly in our case, where $\mathbf{s}_t$ is the credit spread, Eq. (6) gives the parametrisation of the mean spread. Especially the equation shows that the contributions of the stationary variables to the long run average spread are determined by parameter $\boldsymbol{\eta}$.

3. EMPIRICAL RESULTS

The data consists of AA2, AA5, AA10, AAA2, AAA5, and AAA10 Japanese corporate bonds and corresponding maturity Japanese Government bonds (JGBs). The sample period is from January 2, 1995 to October 21, 1998. Following Longstaff and Schwartz (1995), we allow the long yield of the 20-year JGB to represent the risk-free rate. The asset factor is measured in terms of the Nikkei return. It is common in the empirical finance literature to work with continuously compounded variables, which leads to log-returns. Particularly, because we have daily observations, we follow this practice and define the yields as

$$y_t = 100 \cdot \log(1 + Y_t), \quad (7)$$

where Y_t is the yield to maturity on a bond. The credit spreads of maturity n are then simply defined as

$$s_{n,t} = y_{CBn,t} - y_{JGn,t}, \quad (8)$$

where $y_{CBn,t}$ is the yield of a corporate bond with maturity n , and $y_{JGn,t}$ is the corresponding maturity Japan Government Bond yield.

Figure 7.1 depicts the term structure of the (log) credit spreads of the AA and AAA rated Japanese Eurobonds calculated as averages of the daily observation over the sample period for maturities 2, 3, 5, 7, 10 and 20 years. The term structure is slightly humped shaped with the maximum spread occurring for the 3-year corporate bonds in both credit classes. While the spread is decreasing for the AAA rated longer maturity bonds the spread again increases for the AA rated 10-year corporate bonds.

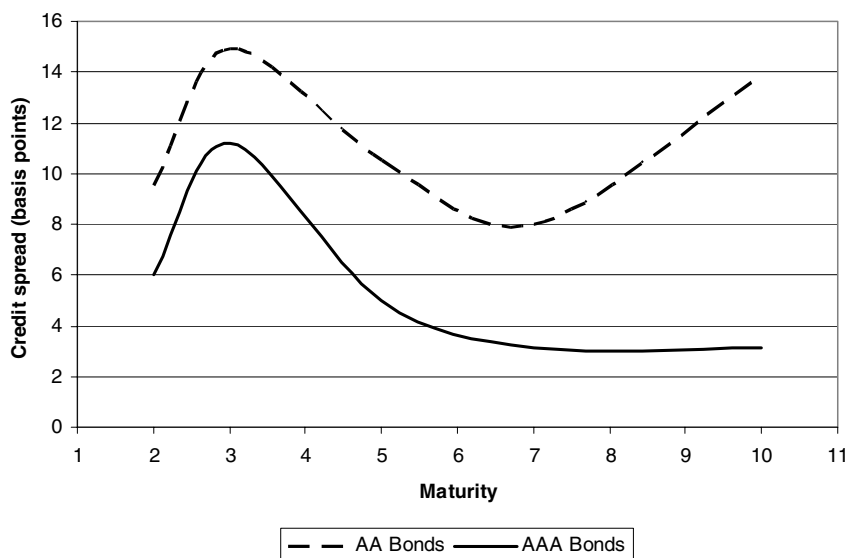


Fig. 7.1. Log Credit Spread Term Structure of Japanese AA and AAA Rated Eurobonds with Maturities 2, 3, 5, 7 and 10 Years, Estimated from Daily Observations with Sample Period from January 2, 1995 to October 21, 1998

Table 7.1

Summary Statistics for log Credit Spreads of Japanese AA and AAA Rated Eurobonds

	AA2 (bp)	AA5 (bp)	AA10 (bp)	AAA2 (bp)	AAA5 (bp)	AAA10 (bp)	Δ JGB20 (%)	Nikkei ret (%)
Mean	9.50	10.50	13.82	6.03	4.98	3.15	-0.003	-0.033
Std	7.78	6.85	7.95	7.25	7.43	7.85	0.045	1.450
Kurtosis	0.82	1.33	5.01	0.05	1.39	6.82	5.750	2.654
Skewness	0.29	-0.31	0.59	0.05	-0.46	-0.15	-0.356	0.083
Minimum	-20.93	-18.61	-19.36	-21.93	-28.37	-32.99	-0.317	-5.957
Maximum	42.19	40.10	77.15	30.43	36.24	68.50	0.230	7.660
N	993	993	993	993	993	993	993	993

The sample period is daily observations from January 2, 1995 to October 21, 1998. The yield spreads are computed as $sp_t = y_{c,t} - y_{g,t}$, where y_c is the corporate daily yield and y_g is the corresponding government bond yield as defined in Eq. (7). The spreads are measured in basis points (1 bp = 0.01%).

Summary statistics for log credit spreads of the yen denominated Eurobonds, Nikkei Daily returns and JGB 20-year log yield changes are presented in Ta-

Table 7.2

I(1) Tests for the log Yields and Spreads, and Cointegration Tests for Various Maturity Japanese Government Bonds (JGBs) with the 20-year JGB

Series	ADF ¹ (level)	p-val	ADF (1. diff)	p-val	Spread	ADF	p-val
AA2	-3.16	0.093	-9.97	0.000	AA2-JGB2	-6.45	0.000
AA5	-3.13	0.100	-8.46	0.000	AA5-JGB5	-6.11	0.000
AA10	-2.10	0.546	-12.65	0.000	AA10-JGB10	-8.89	0.000
AAA2	-3.13	0.100	-12.18	0.000	AAA2-JGB2	-7.66	0.000
AAA5	-3.29	0.068	-8.26	0.000	AAA5-JGB5	-5.68	0.000
AAA10	-2.32	0.421	-35.48	0.000	AAA10-JGB10	-7.80	0.000
JGB2	-2.89	0.165	-14.18	0.000	JGB2-JGB20	-2.02	0.590
JGB5	-2.73	0.224	-34.61	0.000	JGB5-JGB20	-1.77	0.721
JGB10	-2.33	0.418	-15.55	0.000	JGB10-JGB20	-4.04	0.008
JGB20	-2.55	0.304	-6.36	0.000	—	—	—

Johansen (1991, 1995) Trace and Max Eigenvalue test for cointegration of JGB yields

	Trace statistic	Max eigenvalue statistic
JGB2-JGB20	16.43	11.97
JGB5-JGB20	12.52	9.37
JGB10-JGB20	25.76*	22.30*
5% critical value	25.32	18.96
1% critical value	30.45	23.65

* = significant at the 5% level

¹ The Augmented Dickey and Fuller (ADF) test (Dickey, Wayne and Fuller, 1979; Dickey and Fuller, 1981) is based on the regression $\Delta y_t = \mu + \gamma y_{t-1} + \delta t + \phi_1 \Delta y_{t-1} + \dots + \phi_m \Delta y_{t-m} + \varepsilon_t$ with null hypothesis that the series are *I*(1), which implies testing for $\gamma = 0$. The lag-length *m* of the differences is determined by Akaike's (1973) information criterion. The trend and intercept terms are allowed to eliminate their possible effect from the series.

ble 7.1. The mean credit spreads indicate numerically the information presented in Figure 7.1 for maturities investigated in this paper. The standard deviations are between 6.85 and 7.85 basis points, so within the range of one percentage point. This indicates that the volatility is about the same over the maturities. The negative minima of the spreads indicate that there are periods where the yields of the corporate bonds are less than those of the otherwise equivalent government bonds.

From an econometric modelling viewpoint, adoption of the 20-year JGB yield as representative of the risk-free rate could be worked out by including the yield

(which is an $I(1)$ series) in the cointegration relation. Theoretically, this should be well justified, because the expectation hypothesis or the liquidity premium hypothesis predicts that the term spread should be stationary. That is, short and long term JGB yields should be cointegrated (see, e.g., Hall et al., 1992). The second column of Table 7.2 reports the Augmented Dickey–Fuller (ADF, Dickey, Wayne and Fuller, 1979; Dickey and Fuller, 1981) unit root tests for the yields. The null hypothesis of unit root is accepted for all yield series, but strongly rejected for the first differences of the series (fourth and fifth columns). Thus, together these empirical test results support the conclusion that the series are $I(1)$, i.e., integrated of order one.

Columns seven and eight of the table report the unit root test results for the credit spreads of the corporate bonds and the term spreads of the government bonds against the long maturity (20-year) bond. In all cases of the term spreads, the null hypothesis of a unit root is strongly rejected. These results, along with the above unit root findings, suggest that the individual series are best modelled as $I(1)$, and so it is possible to infer that the corporate bonds and otherwise equivalent government bonds are cointegrated with the spread defining the cointegration relation. On the other hand, in the case of term spreads, the unit root tests, reported in three last lines in columns seven and eight, indicate that JGB2 and JGB5 spreads with respect to JGB20 are non-stationary. The JGB10 is an exception for which the test results support stationarity. Even if we allow a more general cointegration relation than the term spread, the hypothesis of cointegration is rejected for the 2- and 5-year bonds as can be seen from the lower panel of Table 7.2, where the Johansen (1991) cointegration test results are reported. Again with the 10-year bond the null hypothesis of cointegration is accepted, supporting the above unit root test result of the spread.

Cointegration of the 10-year JGB with the 20-year JGB with the spread as the cointegration relation has an implication for the modelling of the 10-year corporate bonds. For example, because the spreads define the cointegration relation for both the AAA and JGB 10-year bonds and JGB 20- and 10-year bonds, the dimension of the cointegration space of the yields of AAA10, JGB10 and JGB20 bonds has the rank equal to two, where the spreads identify the cointegration vectors. The implication for modelling of the credit spread then is that the term spread of JGB 20-year and 10-year may have an effect on the dynamics of the credit spreads of AA and AAA 10-year bonds. However, this finding was not confirmed in subsequent regressions and so it is ignored in the final model of the 10-year spreads.

Using the Longstaff and Schwartz (1995) and the empirical results found in Pynnönen, Hogan and Batten (2006), discussed in Section 1, we use in regression (5) besides the lagged spread, the JGB 20-year bond yield change, Nikkei re-

turn, r_t , and the term structure slope change measured in terms of the JGB20 and JGB2 spread change, $\Delta(y_{JG20} - y_{JG2})_t$, where y_{JG20} and y_{JG2} are the log-yields of the 20-year and 2-year JGBs. In addition to account for possible autocorrelation in the residuals we allow for ARMA structure in the residuals, and, furthermore, to model the possible conditional heteroscedasticity, we use GARCH specification, and allow its possible effect on the mean equation as well. Thus augmenting (5) with these factors the estimated models for the spread changes are of the form

$$\begin{aligned}\Delta s_t &= \delta_0 + \delta_1 \sqrt{h_t} + \alpha s_{t-1} + \beta_1 \Delta r_t + \beta_2 \Delta^2 y_{JG20,t} + \beta_2 \Delta^2 (y_{JG20} - y_{JG2})_t \\ &\quad + \eta_1 r_{t-1} + \eta_2 \Delta y_{JG20,t-1} + \eta_3 \Delta (y_{JG20} - y_{JG2})_{t-1} + u_t, \\ u_t &= \phi u_{t-1} + \theta \varepsilon_{t-1} + \varepsilon_t, \\ h_t &= \omega + \gamma_1 \varepsilon_{t-1}^2 + \gamma_2 h_{t-1}\end{aligned}\tag{9}$$

where we have dropped for the sake of simplicity the maturity index from the subscript, and ε_t is the residual term with a GARCH(1, 1) variance process. There are of course other parameterisations of (9), but we find the above choice the most convenient, where we directly identify the equilibrium correction coefficients of the stationary series, and then find the long-run mean spread using Eq. (6).

The Longstaff and Schwartz (1995) model predicts that the signs of β_1 and β_2 should be negative, which imply the increased asset return should decrease the spread and an increase in risk-free return should also decrease the credit spread. The former is intuitive since improved asset return drifts the company asset value up and improves the company's solvency. The negative impact of the risk-free return on the spread is explained in Longstaff and Schwartz (1995) in terms of the risk-neutral pricing process implied by the no-arbitrage pricing mechanism of the bonds and consequently yields. Because the risk-free return serves as the drift in the risk neutral asset value process, the increase of the risk-free return drives the risk neutral asset process away from the default boundary, and hence decreases the (risk-neutral) probability of default. Consequently the spread over the risk-free rate should decrease. The slope of the yield curve is related to state of the economy. Collin-Dufresne, Goldstein and Martin (2001) argue that as the economy moves into recession, the steepness of the yield curve declines. In such an economic phase the asset returns are expected to decrease and hence the firm values decline closer to the default boundary, and therefore increase the default risk. Consequently, the credit spread can be expected to increase, which shows up in (9) with a negative β_3 .

Estimation results and related diagnostic statistics for the selected maturity credit spreads are reported in Tables 7.3 and 7.4. From the tables we find that the cointegration term, the spread s_{t-1} , is highly statistically significant in all cases

Table 7.3

Estimates of the Parameters of Model (9) for AA Rated Japanese Eurobond Corporate Bond Spreads

	$\Delta s2$			$\Delta s5$			$\Delta s10$		
	Coeff	std err	p-val	Coeff	std err	p-val	Coeff	std err	p-val
Constant [δ_0]	0.0064	0.0017	0.000	0.0110	0.0028	0.000	0.0163	0.0038	0.000
Sqrt(h_t) [δ_1]	—	—	—	—	—	—	—	—	—
s_{t-1} [α]	-0.095	0.017	0.000	-0.111	0.024	0.000	-0.140	0.030	0.000
$\Delta^2 \log(\text{Nikkei})_t$ [β_1]	—	—	—	—	—	—	—	—	—
$\Delta^2 y_{JG20,t}$ [β_2]	-0.723	0.053	0.000	-0.665	0.050	0.000	-0.684	0.047	0.000
$\Delta^2 (y_{JG20} - y_{JG2})_t$ [β_3]	0.800	0.045	0.000	0.411	0.052	0.000	0.078	0.036	0.031
$\Delta \log(\text{Nikkei})_{t-1}$ [η_1]	0.0021	0.0007	0.002	—	—	—	0.0015	0.0008	0.072
$\Delta y_{JG20,t-1}$ [η_2]	-0.665	0.062	0.000	-0.559	0.054	0.000	-0.599	0.058	0.000
$\Delta (y_{JG20} - y_{JG2})_{t-1}$ [η_3]	0.738	0.057	0.000	0.358	0.056	0.000	—	—	—
<i>Residual equation</i>									
ar(1) [ϕ]	—	—	—	—	—	—	—	—	—
ma(1) [θ]	—	—	—	-0.217	0.045	0.000	-0.180	0.065	0.006
<i>Variance equation</i>									
Constant ($\times 1000$) [ω]	0.008	0.007	0.218	0.013	0.010	0.174	0.067	0.033	0.042
ε_{t-1}^2 [γ_1]	0.055	0.017	0.002	0.060	0.015	0.000	0.139	0.039	0.000
$\log(h_{t-1})$ [γ_2]	0.943	0.017	0.000	0.935	0.016	0.000	0.845	0.038	0.000
<i>Diagnostics</i>									
N of outliers removed	1	NA	NA	0	NA	NA	1	NA	NA
Observations	991	NA	NA	991	NA	NA	990	NA	NA
Adj. R^2	0.500	NA	NA	0.439	NA	NA	0.480	NA	NA
$s(e)$	0.039	NA	NA	0.046	NA	NA	0.049	NA	NA
Skew z	-0.03	p-val	0.737	-0.09	p-val	0.224	-0.09	p-val	0.259
Kurt z	6.70	p-val	0.000	5.22	p-val	0.000	6.88	p-val	0.000
Jarque-Bera	566.0	p-val	0.000	205.1	p-val	0.000	623.1	p-val	0.000
$Q(2)z$	3.52	p-val	0.172	-0.02	p-val	0.350	0.17	p-val	0.684
$Q(5)z$	4.16	p-val	0.527	-0.01	p-val	0.912	3.10	p-val	0.541
$Q(10)z$	9.16	p-val	0.517	0.02	p-val	0.133	16.35	p-val	0.060
$Q(2)z^2$	1.60	p-val	0.449	-0.04	p-val	0.125	0.47	p-val	0.492
$Q(5)z^2$	2.47	p-val	0.780	0.01	p-val	0.607	3.20	p-val	0.525
$Q(10)z^2$	6.16	p-val	0.801	0.02	p-val	0.813	5.52	p-val	0.787
<i>Estimates of the long run mean spreads [see Eqs. (6) and (10)]</i>									
μ_s (Basis points)	8.42			11.34			13.01		

Dashes indicate variables whose p-values were more than 0.15, and were removed from the final model. Outliers with large residuals were removed. Because the sample size is large the outliers do not materially change the regression results, but they may potentially disturb the ARMA-GARCH residual structure estimation. In the GARCH variance process we have retained the constant term even though the p-value is larger than 0.15. The standard errors are Bollerslev and Wooldridge (1992) heteroscedasticity corrected.

Table 7.4

Estimates of the Parameters of Model (9) for AAA Rated Japanese Eurobond Corporate Bond Spreads

	$\Delta s2$			$\Delta s5$			$\Delta s10$		
	Coeff	std err	p-val	Coeff	std err	p-val	Coeff	std err	p-val
Constant [δ_0]	—	—	—	0.0034	0.0013	0.011	0.0029	0.0011	0.009
Sqrt(h_t) [δ_1]	—	—	—	—	—	—	—	—	—
s_{t-1} [α]	-0.048	0.011	0.000	-0.075	0.019	0.000	-0.111	0.024	0.000
$\Delta^2 \log(\text{Nikkei})_t$ [β_1]	—	—	—	0.001	0.001	0.092	0.001	0.001	0.122
$\Delta^2 y_{JG20,t}$ [β_2]	-0.732	0.041	0.000	-0.640	0.049	0.000	-0.637	0.050	0.000
$\Delta^2 (y_{JG20} - y_{JG2})_t$ [β_3]	0.768	0.041	0.000	0.387	0.050	0.000	0.095	0.036	0.009
$\Delta \log(\text{Nikkei})_{t-1}$ [η_1]	0.0023	0.0007	0.001	0.002	0.001	0.007	0.0020	0.0011	0.064
$\Delta y_{JG20,t-1}$ [η_2]	-0.666	0.050	0.000	-0.519	0.052	0.000	-0.489	0.055	0.000
$\Delta (y_{JG20} - y_{JG2})_{t-1}$ [η_3]	0.688	0.057	0.000	0.303	0.054	0.000	—	—	—
<i>Residual equation</i>									
ar(1) [ϕ]	—	—	—	—	—	—	—	—	—
ma(1) [θ]	-0.105	0.042	0.013	-0.270	0.043	0.000	-0.278	0.044	0.000
<i>Variance equation</i>									
Constant ($\times 1000$) [ω]	0.010	0.008	0.221	0.010	0.009	0.250	0.013	0.010	0.213
ε_{t-1}^2 [γ_1]	0.050	0.019	0.007	0.057	0.014	0.000	0.046	0.013	0.001
$\log(h_{t-1})$ [γ_2]	0.945	0.022	0.000	0.939	0.016	0.000	0.948	0.016	0.000
<i>Diagnostics</i>									
N of outliers removed	0	NA	NA	0	NA	NA	4	NA	NA
Observations	991	NA	NA	991	NA	NA	897	NA	NA
Adj. R^2	0.495	NA	NA	0.425	NA	NA	0.571	NA	NA
$s(e)$	0.039	NA	NA	0.047	NA	NA	0.045	NA	NA
Skew z	-0.19	p-val	0.015	0.00	p-val	0.958	-0.42	p-val	0.000
Kurt z	7.71	p-val	0.000	4.65	p-val	0.000	5.65	p-val	0.000
Jarque-Bera	921.8	p-val	0.000	112.6	p-val	0.000	318.2	p-val	0.000
$Q(2)z$	0.21	p-val	0.649	0.78	p-val	0.377	0.80	p-val	0.371
$Q(5)z$	6.61	p-val	0.158	2.21	p-val	0.697	2.47	p-val	0.651
$Q(10)z$	11.82	p-val	0.224	6.08	p-val	0.732	10.40	p-val	0.319
$Q(2)z^2$	1.12	p-val	0.289	1.55	p-val	0.212	0.96	p-val	0.327
$Q(5)z^2$	1.48	p-val	0.829	2.67	p-val	0.615	6.50	p-val	0.164
$Q(10)z^2$	5.50	p-val	0.789	8.93	p-val	0.443	9.85	p-val	0.362
<i>Estimates of the long run mean spreads [see Eqs. (6) and (10)]</i>									
μ_s (Basis points)	3.31			6.41			4.10		

Dashes indicate variables whose p-values were more than 0.15, and were removed from the final model. Outliers with large residuals were removed. Because the sample size is large the outliers do not materially change the regression results, but they may potentially disturb the ARMA-GARCH residual structure estimation. In the GARCH variance process we have retained the constant term even though the p-value is larger than 0.15.

with a negative coefficient. In the AA case the coefficient ranges from -0.14 to -0.095 , which indicates a fairly slow adjustment in the spread towards the equilibrium. In terms of these estimates the model predicts that a shock of 100 basis points deviation from the equilibrium results to a correction of 9.5 to 14 basis points the next day in the spread. In the AAA case the coefficient estimates are bit lower, ranging from -0.111 to -0.048 .

The other important findings from the regression results are that the contribution of the risk-free interest rate to the equilibrium can be obviously inferred to be negative (estimate of coefficient β_2), exactly as predicted by the Longstaff and Schwartz (1995) model. On the other hand the contribution of the asset factor to the equilibrium does not show up in the estimation results. Its regression coefficient (β_1) estimates is close to being statistically significant at the 10 percent level for AAA5 and AAA10 spreads, and even in these cases the signs are opposite to that predicted by the Longstaff and Schwartz (1995) model. However, the significance of the estimate of η_1 , which is the parameter measuring the asset factor's mean contribution to the average spread is highly statistically significant. Again the sign is opposite to what could be expected from the Longstaff and Schwartz (1995) model. A partial explanation to this may be that the sample period included a rather exceptional time episode in Japanese economy; the negative average daily stock return of -0.033% (about -8.3% p.a.). This implies that the ultimate contribution of the asset return to the average spread becomes negative as predicted by the Longstaff and Schwartz (1995) theory. More generally, we can write Eq. (6) as

$$\mu_s = \mu_{s,c} + \mu_{s,a} + \mu_{s,r} + \mu_{s,y} = -(\mu_c + \eta_1\mu_a + \eta_2\mu_r + \eta_3\mu_y)/\alpha, \quad (10)$$

where $\mu_{s,c} = -\mu_c/\alpha$, $\mu_{s,a} = -\eta_1\mu_a/\alpha$, $\mu_{s,r} = -\eta_2\mu_r/\alpha$ and $\mu_{s,y} = -\eta_3\mu_y/\alpha$ are the asset, risk-free rate and yield curve contributions to the mean spread with μ_c the constant term in the regression and μ_a , μ_r and μ_y asset return, risk-free interest rate and yield curve change long run averages, respectively. Thus, for example, in the case of the AAA rated 10-year bond, we get an estimate for the asset factor equal to $\hat{\mu}_{s,a} = -0.0020 \times (-0.033)/(-0.111) = -0.0006$, or -0.06 basis points. This is obviously small and economically non-insignificant when compared to the total average spread of 4.10 basis points. Thus, in summary, the asset factor's impact cannot be identified clearly in the Japanese markets as a determinant of the credit spread.

The estimate of the asset factor showed up as being weaker than the interest rate factor in Longstaff and Schwartz (1995) and Collin-Dufresne, Goldstein and Martin (2001), but was clearly statistically significant and negative. In both of these studies monthly data was used. It may well be that the daily data used in our

study is too noisy to measure accurately the asset factor. In any case the role of this factor as a proxy for the economic state in the model remains unclear.

The third important factor is the change in the slope of the yield curve. The estimates are highly significant, but again are of opposite sign to what is predicted by Collin-Dufresne, Goldstein and Martin (2001). Again this may be due the sample period covering an exceptional period in the Japanese economy. The average yield curve change, as measured in terms of the spread change of 20-year and 2-year Japan Government bonds, has been slightly negative.

In the GARCH volatility process all the estimates, except the constant term, are highly significant. Thus there is obvious conditional heteroscedasticity in the credit spread. The sum of the GARCH parameter estimates of γ_1 and γ_2 is in most cases close to one, indicating that the volatility process is close to being integrated with a weight 0.05 for the latest shock and 0.95 for the persistence. With these weights the volatility process is in any case fairly smooth. The changing volatility, however, does not show up in the mean equation.

4. SUMMARY AND CONCLUSIONS

In an important paper Longstaff and Schwartz (1995) derive a closed form solution for the price of a risky bond under the arbitrage-free assumption. Their model predicts that the yield spreads should be a negative function of both the firm asset return and the risk-free interest rate. The model is an equilibrium solution, where price adjustments are assumed to take place immediately. Nevertheless, in real discrete time trading there are delays and frictions that constitute feedbacks between integrated price series. This implies that a non-stationary series may become cointegrated. That is, a linear combination of the series is stationary. This study shows that there is strong empirical evidence that the Japanese yen Eurobond yields are cointegrated with the equivalent maturity Japanese Government Bonds (JGBs) with the spread defining the cointegration relation.

Because cointegration leads to incomplete markets, we cannot rely upon arbitrage-free pricing but instead on equilibrium pricing, where the markets clear via potentially complicated adjustment processes. Taking the spread as the core of the equilibrium cointegration relation we derive a model, where the contribution of stationary series, like the asset return and the change in the risk-free rate, to the equilibrium relation can be estimated and tested. The equilibrium correction term of the cointegration relation is found to an important determinant in the adjustment process of the spread to the equilibrium in each of the investigated series. Furthermore, the results suggest that the adjustment process is fairly slow. Of the stationary series the most important factor with the predicted sign by Longstaff

and Schwartz (1995) is the risk-free interest rate. The asset return, on the other hand, does not show up as a significant factor in the equilibrium. The slope of the yield curve of Government bonds, which is intended to reflect the phase of the economy, turned out to also be statistically significant, but with the opposite sign to what would be expected. Thus the real role of this variable remains unclear.

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Chapter 8

HEDGING MARKET-WIDE CREDIT RISK USING CDS INDEXES: THE CASE OF JAPAN

Hans Byström

Abstract

Recently, tradable credit default swap (CDS) indexes were introduced in the US, in Europe and in various Asian-Pacific markets. These indexes represent portfolios of single-name CDS contracts and they allow investors to buy or sell market-wide credit risk in one transaction. In this paper we look at the Japanese *iTraxx CJ* index, and assess to what degree this CDS index can be used to protect against market-wide credit risk in Japan. We find the *iTraxx CJ* index to be significantly correlated not only with an equally weighted stock portfolio of the 50 names in the CDS index itself, but also with the much broader *Nikkei 225* index; stock index levels and stock index returns are significantly negatively correlated with the CDS index spread and spread changes and stock index volatilities are significantly positively correlated with the CDS index spread. Since theory predicts the value and volatility of a firm's stock to be directly related to the default probability of the firm and, furthermore, since the CDS index spread is supposed to reflect this probability, we believe the sign and size of the estimated correlations to be evidence of how the Japanese *iTraxx CJ* index can be used as a (proxy) hedge against overall Japanese credit risk.

1. INTRODUCTION

Among all the risks facing investors, credit risk is by far the largest and most widely dispersed. Credit risk is the risk that a counterparty or borrower does not fulfill his or her obligations and more or less all investments give rise to credit risk. Credit risk is therefore very important to measure and manage as accurately as possible.

One efficient way of managing credit risk, whether it is the credit risk associated with an individual asset or whether it is portfolio-wide credit risk, is to use so

called credit derivatives. These derivative contracts transfer the credit risk of an underlying asset from one counterparty to another without actually involving the underlying asset in any way. The market for credit derivatives has grown tremendously the last couple of years and in June 2004 notional amounts for credit derivatives amounted to USD4.5 trillion which was almost seven times the notional amounts outstanding three years earlier (BIS, 2004). The growth has continued with similar strength in 2004 and 2005 and the sheer size of the global exposure to credit risk indicates an enormous potential for the credit derivatives market in the years to come.

In this paper we focus on the largest of the various credit derivatives markets, the credit default swap (CDS) market, which is a market for insurance against credit events (bankruptcy, restructuring, delayed debt payments, etc.). In 2004, an important step was taken in the history of the global credit markets when *Dow Jones* and *International Index Company* (a company owned by the major global investment banks) merged two earlier families of CDS indexes into one single liquid and tradable family of CDS indexes called *Dow Jones iTraxx* indexes in Europe and in various Asian-Pacific markets. In the US, similar *Dow Jones CDX* indexes were also introduced in 2004 by the same companies. All these indexes represent portfolios of single-name CDS contracts and they all allow investors to buy or sell market-wide credit risk in one transaction. The *iTraxx* and *CDX* indexes are highly liquid and transparent instruments that establish credit as its own asset class and this has attracted investors from all sectors of the financial market.

The most important determinant of the value of a credit default swap, and consequently of a credit default swap index, is the probability of the underlying (reference) firm(s) being exposed to a credit event at some future point. This probability is hard to determine exactly but extensive work in the field of default probability modelling is continuously making default forecasts more accurate. Most modern default predictors use information from the financial markets in one way or another and for listed firms the probability is often estimated using information contained in the firm's stock price. These models rely on the efficient market hypothesis to hold for the stock market and the most well known approach of calculating the default probability of a firm (and the credit spread of the firm's debt) using information from the stock market is the Merton (1974) model. This model uses the amount of outstanding debt of the firm together with its stock market value and variability as the main drivers of default and the Merton (1974) model and its offsprings have proved successful in predicting both outright defaults and gradual deteriorations/improvements in the credit quality of a firm.¹

¹ Two widely used commercial models built around the original Merton (1974) model are the *Moody's* | *KMV* model and the *CreditGrades* model.

In this paper we look at market wide credit protection in Japan; i.e. we look at the issue of how to hedge against a general credit deterioration in corporate Japan. The easiest, if not only, way of doing this is to turn to the credit default swap market and in this paper our goal is to assess the effectiveness of this particular market in Japan. More exactly, we want to investigate whether the newly introduced *iTraxx CJ* index of credit default swaps is behaving in a way consistent with theory and whether it can be used to protect the investor against overall credit risk in the Japanese corporate sector. In order to do this we draw on earlier theoretical research, for instance Merton (1974), where the value of a firm's stock and the volatility of its stock returns are suggested to be the main determinants of the firm's credit risk. We interpret the term "firm" in an aggregate sense and create a stock portfolio containing the same firms as the *iTraxx CJ* index and calculate correlations between this portfolio's value and volatility and the CDS index spread. We also investigate whether the valuation and volatility of the market-wide *Nikkei 225* index is correlated with the 50-firm based *iTraxx CJ* CDS index. Overall, we find the various correlations large enough to lend support to the hypothesis that the *iTraxx CJ* CDS index can be used as a possible hedge against market-wide Japanese credit risk even in the case when the underlying firms in the market-wide portfolio are not identical to those in the CDS index itself. We also find some evidence of a lead-lag relationship where yesterday's stock returns determine today's CDS spread changes, and the fact that information seems to be transmitted faster through the stock market than through the CDS market could be exploited by for instance capital structure arbitrageurs.

The results in this study can be compared to earlier studies on the *iTraxx* market in Europe where Byström (2005a) finds a close relationship between both the value and the volatility of stock portfolios in various industrial sectors and corresponding *iTraxx* indexes. A distinct lead-lag relationship where the stock market seems to lead the CDS market is also observed in the European market. Furthermore, in an other paper, Byström (2005b), it is demonstrated that CDS index spreads observed in the market and spreads computed with the *Credit-Grades* model are linked to each other. Finally, Byström (2005a) finds a significant amount of autocorrelation in the European *iTraxx* market and that is something we also find in the Japanese *iTraxx CJ* market.

Earlier literature on the relationship between CDS markets and stock markets has exclusively studied single-name CDS contracts. In one of the first studies Longstaff, Mithal and Neis (2003) looks at the US CDS market without finding any significant lead-lag relationship between the stock market and the CDS market. Norden and Weber (2004) looks at credit default swaps in Europe, US and Asia, and finds CDS spread changes to be negatively correlated with stock returns. Furthermore, stock returns seem to lead CDS spread changes.

Blanco, Brennan and Marsh (2005) also investigates the determinants of CDS spreads and finds that stock returns, both in US and in Europe, have an impact on CDS spreads. Finally, Blanco, Brennan and Marsh (2005) is one of the first papers that investigates stock volatilities in this context and these authors find a significant link between implied stock volatilities and CDS spreads.

The rest of this paper is organized as follows. The second section briefly discusses credit default swaps and gives a short introduction to the *iTraxx* credit default swap index market, particular the Japanese *iTraxx CJ* market. Section two also discusses the link between the equity market and the credit default swap market while section three presents the data and the empirical results. Section four, finally, concludes the paper.

2. THE *iTraxx CJ* CDS INDEX MARKET

Credit default swaps isolate the credit risk component from other risks and therefore allow investors, whether they are speculators, hedgers or arbitrageurs, to buy or sell pure credit risk. A credit default swap can be seen as an insurance contract that protects the buyer against losses from a certain credit event involving a certain firm; the buyer of the CDS contract pays the seller of the contract a periodic fee, the CDS spread, and if a credit event strikes the underlying firm, then the buyer typically delivers the debt owed by the firm to the seller in return for a sum equal to the principal. The liquidity of the major CDS markets has increased over the last couple of years and today's CDS contracts are not only used by speculators and arbitrageurs as an efficient way of taking long or short positions in certain credits but the CDS market also gives signals to risk managers regarding the credit health of borrowers and other counterparties. Considering the counterparty credit risk that exists in any derivative transaction, this way of producing "market based credit ratings" certainly is an important function of the CDS market.

Just like a stock index is based on a portfolio of stocks, a CDS index is based on a portfolio of single-name credit default swaps. Theoretically, CDS indexes therefore function and behave just like single-name CDS contracts but, being based on a large number of individual CDS contracts, provide investors with market-wide or sector-wide credit risk exposure or protection. The concept of a credit index was born in 2001 with *Morgan Stanley*'s launch of the so-called *Tracers*, which were pools of corporate bonds, and the *Synthetic Tracers*, which were similar pools of CDS contracts. In 2003, *Morgan Stanley* joined forces with *JP Morgan* and launched a new CDS index with a wider coverage called *Trac-x*. There were some other competing indexes around at the time but it was not until a group of large rival investment banks launched the *CDX* index (under the *iBoxx* brand) in

North America that we had two competing CDS indexes in the market, *iBoxx* and *Trac-x*. Unfortunately, the two competing indexes created a market that was divided into two blocks of dealers that each marketed and traded only their preferred index. This division hampered liquidity and the appeal of the CDS index market was further limited by the uncertainty among users as to which of the indexes that would ultimately “survive”. The solution came in 2004 with the announcement that the two indexes were about to be merged—as *iTraxx* in Europe and Asia and as *CDX* in the US. The merger meant that there would now be only one single index for everyone to focus on, something that contributed to what today is the key reason for the popularity of the indexes, their high liquidity; the CDS index market is often liquid even when the underlying single-name CDS market is illiquid. Furthermore, the existence of a broad based CDS index speeds up the time it takes to create a diversified credit portfolio considerably and the indexes clearly serve as useful investment vehicles. Furthermore, the fact that there is now only one index in the market encourages the development of new index based products like index futures and index options.

The North-American *CDX* index family was introduced in April 2004 and the *iTraxx Europe* index family was introduced two months later in June 2004 by *Dow Jones* and the newly created *International Index Company*.² In July 2004 similar indexes were also introduced in the Japanese market, the Australian market and the non-Japanese Asian market (*iTraxx CJ*, *iTraxx Australia*, *iTraxx Asia ex-Japan*). Most of these market-wide indexes are also available as regional or sectoral sub-indexes. The *iTraxx* indexes are made up of the most liquid CDS contracts in the sector or market they cover and, being liquid and transparent, they significantly reduce the cost for investors to gain exposure to diversified portfolios of credit.

In the case of Japan, the *iTraxx CJ* index is used as a benchmark index. *iTraxx CJ* is built on the earlier *CJ 50* index and consists of 50 equally weighted Japanese names (liquid investment grade CDS contracts of Japanese corporations and banks) selected by a market maker poll based on CDS volume traded over the previous twelve months (IIC, 2005). The number of firms is limited to 50 because of liquidity constraints; there are simply not enough liquid names in the Japanese CDS market to support a wider range of firms even though this would create an index that would be more representative of the overall Japanese market. In addition to the overall index, several sector indexes are also traded; there is a *Financials* sub-index, a *Technology* sub-index, a *Capital goods & others* sub-index, and a *HiVol* sub-index containing the 10 names with the widest CDS spreads from a list

² *Dow Jones* markets and licenses the indexes and *International Index Company* manages them. *International Index Company* is owned by ABN Amro, Barclays Bank, BNP Paribas, Deutsche Börse, Deutsche Bank, Dredner Kleinwort Wasserstein, JP Morgan Chase, Morgan Stanley and UBS.

of 100 names. All the *iTraxx* indexes start out with 5 1/4 and 10 1/4-year maturities and the composition of the main index is reviewed and adjusted according to a new market maker poll every six months (March and September).

The introduction of liquid CDS *iTraxx* indexes in all these markets has made it easy to exploit beliefs regarding counterparty credit risk, and market participants all over the world can use the tools for a wide range of purposes; risk managers in banks and insurance companies can (proxy) hedge sector-wide credit exposures in a quick and easy way, portfolio managers can tailor synthetic credit risky portfolios using risk-free covered bonds together with a position in an *iTraxx* index and in this way execute credit views efficiently, hedge funds can go long or short in credits in a certain market very efficiently and execute relative-value trades between sectors, etc., credit correlation trading desks can execute arbitrage strategies involving the CDS index, the constituent credit default swaps and corresponding stocks and bonds, and financial supervisors and central banks can use CDS indexes as an additional measure of the stability of various sectors of the economy, most notably the banking sector.³ Furthermore, the standardized *iTraxx* indexes could serve as highly liquid benchmarks of credit portfolios from which one could develop new structured products and they could open up for second generation credit derivatives based on CDS indexes.

The spread (price) of a CDS contract is determined by how creditworthy the underlying firm is and, as mentioned above, this creditworthiness is often determined using information from the stock market; since credit risk is expected to be priced by the stock market the underlying firm's stock price and its dynamics is expected to contain information regarding the firm's credit stance. Regardless of whether the Merton (1974) model, the *CreditGrades* model or any other stock market based model is used to compute the default probability (a measure of credit health) of a certain firm, the probability is generally a function of the firm's stock price (the lower the market value the likelier a default is), its stock price volatility (the higher the volatility the likelier a default is) and its debt to equity ratio (the higher the debt to equity ratio the likelier a default is).⁴ Since the most important determinant of the CDS spread is the credit health of the underlying firm, i.e. the

³ Basel II, the new regulatory framework developed by the Basel Committee, encourages the use of market information to manage credit risk. Liquid and tradable CDS indexes serve this purpose very well and the coming implementation of Basel II in various countries is an additional reason behind the growing popularity of both single-name CDS and CDS indexes. In Japan, the Financial Services Agency (FSA), has set the deadline for the roll out of Basel II to April 1, 2007 for those banks that aim for the standardized approach or the foundation internal approach and April 1, 2008 for those banks that want to apply the advanced internal approach to manage their credit risk.

⁴ We refer to Merton (1974) for the basic theory behind the stock market based default probability models.

likelihood that a credit event involving the underlying firm occurs, and since theory tells us that this probability should be linked to the stock market valuation as well as the stock return volatility of the reference entity it is natural to investigate empirically the link between the stock market and the CDS market.

We do exactly that in this paper and our findings indicate some existing arbitrage possibilities in the Japanese CDS market. One group of investors that might be particularly interested in this link are capital structure arbitrageurs (Currie and Morris, 2002). These investors try to detect inconsistencies between the stock market and the CDS market and try to make arbitrage profits by taking positions in the CDS market and hedging them in the stock market or vice versa. If, for instance, the stock market leads the CDS market then arbitrageurs that document this swiftly and accurately enough can make profits by taking appropriate positions in the CDS market based on previous movements in the stock market.

3. EMPIRICAL STUDY: THE *iTraxx CJ* CDS INDEX AND EQUITY PRICES IN JAPAN

The main purpose of this paper is to study the Japanese *iTraxx CJ* CDS index and its relationship with the stock price movements of the underlying entities making up the index. From a theoretical point of view, we expect to find a large CDS index spread when the stock market valuation is low and the stock return volatility is high and vice versa. Furthermore, we also want to investigate whether the *iTraxx CJ* index can be used to hedge the market-wide credit risk in the widely used *Nikkei 225* index. Of course, the *iTraxx CJ* index is based on only 50 firms while the *Nikkei 225* index is based on a portfolio of 225 firms and therefore we do not expect a perfect hedge. However, the *degree* of effectiveness of the *iTraxx CJ* index in protecting against market-wide credit risk is worth studying and as far as we know this is the first attempt of doing that.

3.1. Data and Empirical Setup

We have downloaded daily 5-year maturity CDS spreads (the mid-points between quoted bid and ask spreads at the end of the trading day) for the benchmark *iTraxx CJ* index from the *International Index Company* web site and we cover the time period July 26, 2004–June 3, 2005. The maturity of the CDS index is 5 years and the constituent swaps are denominated in Japanese Yen. We cover more or less the entire first year of the life of the *iTraxx CJ* index, and compared to earlier studies, where individual credit default swaps are used, our data series are of very high quality in the sense that all quotes are true market quotes, that all quotes

Table 8.1

The 50 Names in the *iTraxx CJ* CDS Index. All the names have equal weighting in the index (2%). On March 18, 2005 *Asahi Breweries Ltd.* was replaced with *Shimizu Corp*

ACOM	Kintetsu	Sapporo Holdings
AEON	Komatsu	Sony
AIFUL	Mitsubishi	Sumitomo Chemical
All Nippon Airways	Mitsubishi Estate	Sumitomo
Asahi Breweries/Shimizu	Mitsubishi Heavy Industries	Sumitomo Electric Industries
Asahi Glass	Mitsui & Co.	Sumitomo Mitsui Banking
Bridgestone	Mitsui Fudosan	Takefuji
Chubu Electric Power	Mizuho Corporate Bank	The Bank of Tokyo-Mitsubishi
Fujitsu	NEC	The Kansai Electric Power
Hankyu	Nikon	The Tokyo Electric Power
Hitachi	Nippon Steel	Tokyo Gas
Ishikawajima-Harima Heavy	Nissan Motor	Tokyu
Industries	Nomura Securities	Toppa Printing
Japan Airlines	NTT Docomo Inc.	Toshiba
JFE Steel	Obayashi	Toyota Motor
Kajima	ORIX	UFJ Bank
Kawasaki Heavy Industries	Promise Co.	Yamaha Motor

are directly comparable to each other and that all the quotes are sampled on a daily basis. Even though earlier studies might be using data sets that are longer than ours, they often suffer from using CDS quotes that are collected from many sources and with a varying sampling frequency along the sample.

The *iTraxx CJ* index is based on 50 individual names, and in order to study the link between the CDS market and the stock market in Japan we construct stock portfolios containing exactly the same names (firms) as the CDS index.⁵ The names in this “*iTraxx*” stock index, as we call it, are listed in Table 8.1 and the time period covered is the same as for the CDS index. Since the *iTraxx CJ* index is equally weighted in the underlying CDS contracts the “*iTraxx*” stock portfolio is also constructed as an equally weighted portfolio. The first day in the sample we construct an equally weighted stock index and thereafter we do no re-balancing of our index portfolio. An updated *iTraxx CJ* reference portfolio is introduced every six months by the *International Index Company* (IIC, 2005), but for us the impact of this feature of the market is minimal; we only have to replace one firm, *Asahi Breweries Ltd.*, with *Shimizu Corp.* on March 18, 2005. In addition to the “*iTraxx*” stock index we also collect daily quotes of the *Nikkei 225* index for the same time

⁵ The data was downloaded from the *EcoWin* database.

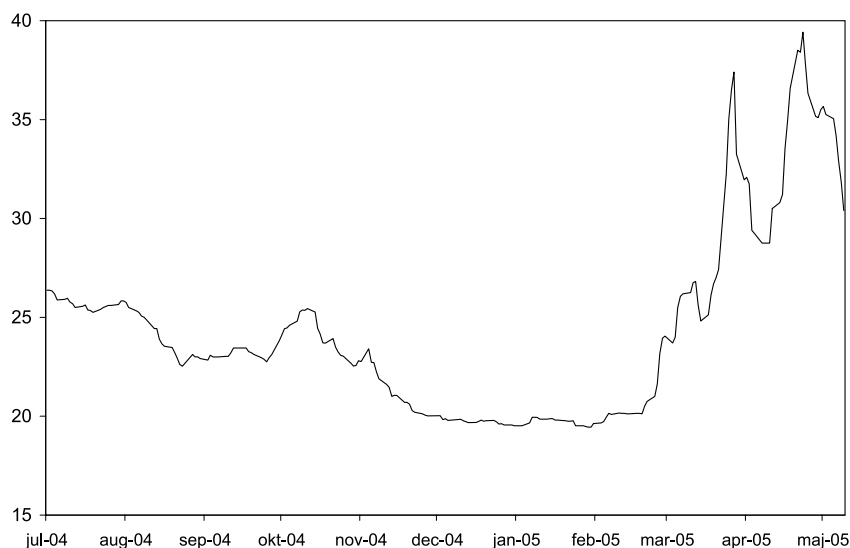


Fig. 8.1. The Spread of the 5-Year *iTraxx CJ* CDS Index (in Basis Points) over the Time Period July 26, 2004–June 3, 2005

period as for the other data series.⁶ Finally, we estimate stock return volatilities for the two stock indexes and for robustness reasons we estimate the volatilities using six different historical window sizes (1 month, 2 months, 3 months, 6 months, 1 year and 2 years) as well as using the Exponentially Weighted Moving Average (EWMA) volatility estimator originally suggested by *RiskMetrics*. The idea behind the EWMA estimator is to put less and less weight to historical observations the older they are. Like most previous studies we follow the original *RiskMetrics* document (RiskMetrics, 1996) and choose a smoothing parameter $\lambda = 0.94$, an unconditional mean = 0 and truncate the infinite history to the 250 past observations.

3.2. Introductory Descriptive Statistics for the *iTraxx CJ* Spreads

We start by presenting some statistical features of the *iTraxx CJ* CDS spread and spread changes in Table 8.2. The spread is given in basis points and in Figure 8.1 we can see how it varies over time. Over the first ten months after its introduction the *iTraxx CJ* spread is steadily tightening, but in March 2005 the pattern is broken

⁶ The data was downloaded from the *Yahoo Finance* web site.

Table 8.2

Descriptive Statistics for 5-Year *iTraxx CJ* CDS Index Spreads (Levels and Changes) and Stock Indexes (Levels and Changes) over the Time Period July 26, 2004–June 3, 2005. Skew indicates skewness, Kurt indicates excess kurtosis and $Q(L)$ are Ljung–Box tests for autocorrelation up to lag L . 1%, 5% and 10% significance levels are indicated by ***, ** and *, respectively

LEVELS			
	Daily CDS spreads (bp)	Daily “ <i>iTraxx</i> ” stock index levels (normalized)	Daily <i>Nikkei</i> 225 stock index levels (normalized)
Mean	24.36	1.029	1.007
Stdev	4.71	0.036	0.029
Min	19.45	0.96	0.96
Max	39.42	1.11	1.07
CHANGES			
	Daily CDS spread changes (%)	Daily “ <i>iTraxx</i> ” stock returns (%)	Daily <i>Nikkei</i> 225 stock returns (%)
Mean	0.065	0.016	0.0057
Stdev	2.28	0.83	0.86
Min	−11.76	−3.63	−3.88
Max	16.22	2.24	2.65
Skew	1.40	−0.13	−0.22
Kurt	15.84	1.49	1.80
$Q(6)$	58.15***	1.59	3.26
$Q(12)$	81.42***	6.00	10.83
$Q(24)$	134.99***	22.25	28.18

and the spread is suddenly widening sharply. Since the *iTraxx CJ* spread can be interpreted as the average credit spread across the Japanese corporate debt market this reversal signals a sudden change in the market’s opinion about the credit quality of the Japanese credit universe.

The reason behind the sudden change in opinion is, most likely, the problematic situation for the giant US car manufacturer *General Motors*; at the time, in March and April 2005, the market expected a downgrade of *General Motors*’ credit rating and on May 5 *General Motors*’ debt, together with *Ford*’s, was eventually downgraded to speculative grade debt. Much of the turbulence in the US car industry did spread to the European debt market, see Byström (2005a), and, as we will see in this study, it also seems to have spread to the Japanese debt market. Compared to the European *iTraxx* sector spreads the *iTraxx CJ* spread is lower than all European spreads except the *senior financial* sector, at least up until

the sudden widening in March 2005 (see Byström, 2005a). When it comes to the volatility, however, the figures in Table 8.2 tell us that the Japanese index is about as volatile as the typical European sector index and much more volatile than, for instance, the European *senior financial* sector.

In addition to the dynamics of the spread we also look at the spread change dynamics, and in the lower part of Table 8.2 we present some statistics for these changes. If we compare the *iTraxx CJ* index spread change distribution with the distributions of the corresponding “*iTraxx*” and *Nikkei 225* stock indexes we find the Japanese CDS market to be much more volatile than the Japanese stock market. Similar to the situation in Europe, the Japanese *iTraxx CJ* index is about three times as volatile (with a sample standard deviation equal to 36% on an annual basis) as the two stock indexes (with sample standard deviations equal to 13% on an annual basis). Looking at the two markets’ reactions to extremely bad news, the largest positive spread change observed from one day to the next is around 16% while the corresponding largest negative stock returns are around -4% for the two stock index returns. The relative reactions to extremely good news are similar but the absolute size is smaller, both for the stock index and the CDS index. Consistent with this, we find the spread change distribution to demonstrate much more skewness and kurtosis than any of the two stock index return distributions. Again, these results are similar to those found in Byström (2005a) for the *iTraxx* Europe market. Finally, an important feature of the CDS spread dynamics, that also was found in Europe, is the significant autocorrelation; the Ljung–Box test statistics in Table 8.2 are all highly significant while the same statistics for the stock returns are non-significant. As mentioned in Byström (2005a), the autocorrelation can be viewed as evidence of inefficiencies in the CDS market, and of the possible existence of profit possibilities for informed investors exploiting this regularity.

3.3. *The Link between the CDS Market and the Stock Market in Japan*

As mentioned before, the main purpose of this paper is to study the link between *iTraxx CJ* spreads and corresponding stock portfolios, and in Table 8.3 we present correlations, both ordinary Pearson sample correlations and Spearman rank correlations, between the CDS index spreads, the stock index prices and the volatilities of the stock index returns. We also present correlations for the changes in CDS spreads and stock prices, including cross-serial (lead-lag) correlations.

Theory (Merton, 1974, etc.) tells us that credit spreads should be negatively related to stock prices. Furthermore, if the stock market and the CDS market are not equally quick to incorporate information, we would expect to find non-zero cross-serial correlations; i.e. lagged stock price changes should be related to cur-

Table 8.3

Correlations between 5-Year *iTraxx CJ* CDS Index Spreads (Levels and Changes), Stock Indexes (Levels and Changes) and Stock Index Return Volatilities over the Time Period July 26, 2004–June 3, 2005. Correlations indicate ordinary Pearson correlations and Rank Correlations indicate Spearman rank correlations. 1%, 5% and 10% significance levels are indicated by ***, ** and *, respectively

	Correlations	
	Levels	Changes
<i>“iTraxx”</i> stock index		
CDS index vs. stock index	−0.28***	−0.21***
CDS index vs. lagged stock index		−0.22***
Lagged CDS index vs. stock index		0.04
CDS index vs. 1 Month stock index volatility	0.51***	
CDS index vs. 2 Month stock index volatility	0.42***	
CDS index vs. 3 Month stock index volatility	0.13**	
CDS index vs. 6 Month stock index volatility	−0.10*	
CDS index vs. 1 Year stock index volatility	−0.38***	
CDS index vs. 2 Year stock index volatility	−0.33***	
CDS index vs. EWMA stock index volatility	0.51***	
<i>Nikkei 225</i> stock index		
CDS index vs. stock index	−0.34***	−0.22***
CDS index vs. lagged stock index		−0.20***
Lagged CDS index vs. stock index		0.02
CDS index vs. 1 Month stock index volatility	0.39***	
CDS index vs. 2 Month stock index volatility	0.27***	
CDS index vs. 3 Month stock index volatility	0.01	
CDS index vs. 6 Month stock index volatility	−0.18***	
CDS index vs. 1 Year stock index volatility	−0.30***	
CDS index vs. 2 Year stock index volatility	−0.31***	
CDS index vs. EWMA stock index volatility	0.36***	

rent CDS spread changes and vice versa. From theory we would also expect credit spreads to be positively related to stock return volatilities and for robustness we estimate volatilities using various windows of historical stock returns.

In this subsection we look at the stock index containing the same 50 names as the *iTraxx CJ* index, i.e. the “*iTraxx*” stock index, and we wait with introducing the *Nikkei 225* index until the next subsection. Starting with the levels, in Table 8.3 we find fairly large negative correlations (between the CDS spreads and the stock prices) of −0.28 and −0.36 for the ordinary correlation and the rank correlation, respectively. Both correlation estimates are significant at the 1% level, and the

Table 8.3
Continued

	Rank Correlations	
	Levels	Changes
<i>"iTraxx" stock index</i>		
CDS index vs. stock index	-0.36***	-0.05
CDS index vs. lagged stock index		-0.05
Lagged CDS index vs. stock index		0.04
CDS index vs. 1 Month stock index volatility	0.59***	
CDS index vs. 2 Month stock index volatility	0.48***	
CDS index vs. 3 Month stock index volatility	0.21***	
CDS index vs. 6 Month stock index volatility	-0.01	
CDS index vs. 1 Year stock index volatility	-0.11**	
CDS index vs. 2 Year stock index volatility	-0.11**	
CDS index vs. EWMA stock index volatility	0.59***	
<i>Nikkei 225 stock index</i>		
CDS index vs. stock index	-0.36***	-0.03
CDS index vs. lagged stock index		-0.06
Lagged CDS index vs. stock index		0.02
CDS index vs. 1 Month stock index volatility	0.53***	
CDS index vs. 2 Month stock index volatility	0.33***	
CDS index vs. 3 Month stock index volatility	0.07	
CDS index vs. 6 Month stock index volatility	-0.06***	
CDS index vs. 1 Year stock index volatility	-0.11**	
CDS index vs. 2 Year stock index volatility	-0.12**	
CDS index vs. EWMA stock index volatility	0.46***	

negative sign is in accordance with theory; the spread of the CDS index is wide when the value of the stock portfolio is low and vice versa. To further test the robustness of our results we repeat our analysis but with the last two months, April 3–June 3, of the data removed. These are the two months when we expect a significant spill-over effect from the “*General Motors* contaminated” US credit market, and the result from removing the last two months is that the link between the stock market and the CDS market becomes even stronger (with a correlation of -0.59). The interpretation of this increase is left for another study and here we just interpret it as indicating some robustness of our results.

As for the stock index volatility we expect it to be positively correlated with the CDS spread. Looking at the results in Table 8.3, however, we only find the expected positive relationship for volatilities estimated using short window lengths

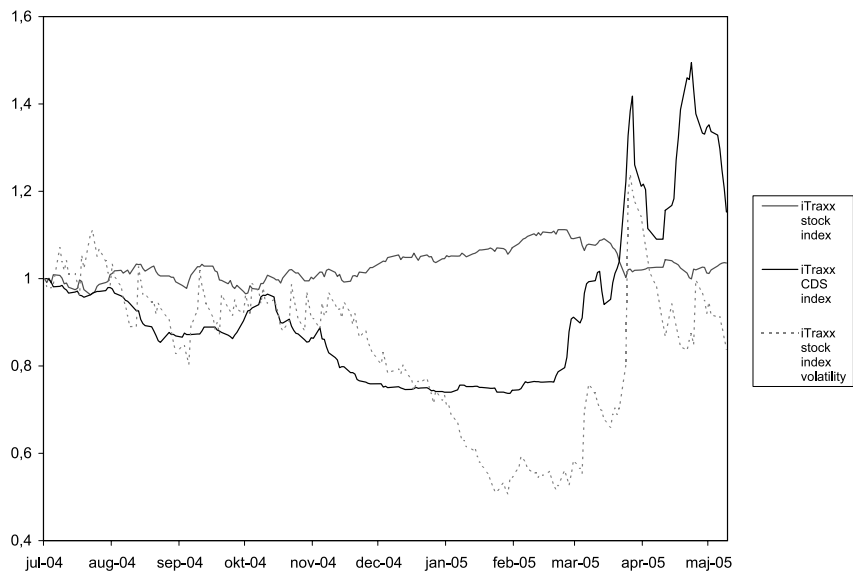


Fig. 8.2. The 5-Year *iTraxx* *CJ* CDS Index Spread, the Corresponding “*iTraxx*” Stock Index, and the “*iTraxx*” Stock Index Return EWMA Volatility (All Normalized to Start at One) over the Time Period July 26, 2004–June 3, 2005

and for the Exponentially Weighted Moving Average (EWMA) volatility. The relationship is strongest for the EWMA estimator and for the 1-month historical volatility; the ordinary correlations and the rank correlations, respectively, for both these two estimators are equal to 0.51 and 0.59. For many of the longer windows, though, we, surprisingly, find negative correlations. This pattern is different from the results in (Byström, 2005a) where stock return volatilities consistently were found to be positively related to CDS spreads, regardless of which industrial sector was looked at and regardless of the length of the estimation window. One likely reason is the sudden widening of the CDS index spread towards the end of the sample and that the historical stock volatility estimators with long windows are slow to react to this. This would result in low correlations between the volatility and the spread and, as a matter of fact, when we again remove the last two months (April 3–June 3) from our sample we get highly significant positive correlations (between 0.50 and 0.74) regardless of window length.

Figure 8.2 shows the *iTraxx* *CJ* CDS spread and the corresponding “*iTraxx*” stock index normalized to start at one. The pattern in Figure 8.2 pretty much confirms the correlation results in Table 8.3 and demonstrates the significant negative

relationship that exists between the CDS market and the stock market. Furthermore, the significant relationship between CDS spread levels and the (EWMA) stock index volatility is also demonstrated in Figure 8.2 where the spread clearly widens when the stock volatility increases and vice versa. Only the link between the CDS spread and the volatility remains throughout the sample, however, and the close relationship between the spread and the stock index itself is broken for the last two months where the CDS spread varies a lot at the same time as the stock index value more or less remains constant. This change in pattern is consistent with the increased correlation found above when the last two months were excluded from the analysis.

Continuing the search for links between the CDS market and the stock market we turn to day to day changes in our index values. The two contemporaneous correlations in Table 8.3 are in accordance with theory (negative) but only the ordinary correlation is significant at the 1% level (-0.21). The rank correlation is very small and non-significant (-0.05). Furthermore, one-day lagged stock returns are found to be as strongly negatively correlated with current CDS spread changes as current stock returns (but, again, only the ordinary correlation is significant). This lead-lag relationship is not found when we reverse the causal direction and the one-way cross-serial correlation is evidence supporting the hypothesis that information flows *from* the stock market *to* the CDS market and not vice versa. Does this mean that investors can use the stock market to predict changes in market spreads of Japanese CDS contracts? It clearly is an indication of this, even though the rank correlations are non-significant, but to answer the question satisfactory one probably needs to evaluate the performance of various trading strategies that exploit spread predictions made by the stock market.⁷ Finally, contrary to when we looked at the levels, none of the results for the changes were substantially changed when we removed the last two months of our sample.

To summarize, the results in this subsection are overall confirming our expectations and most results are in accordance with theory. Two exceptions are the negative correlations between long-window historical volatilities and CDS spreads and the non-significant rank correlation between stock index changes and CDS spread changes. As demonstrated above, the first anomaly can probably be explained by the well known ghost effect associated with using long historical estimation windows with equal weights given to all observations. The strong link between the EWMA volatility and the CDS spread, on the other hand, is fully in accordance with expectations. The good performance of the EWMA estimator is no surprise since, after all, the EWMA estimator probably is a more reasonable choice than

⁷ Byström (2005b) touches upon this issue using the well known *CreditGrades* model to calculate European CDS index spreads using information from the European stock market.

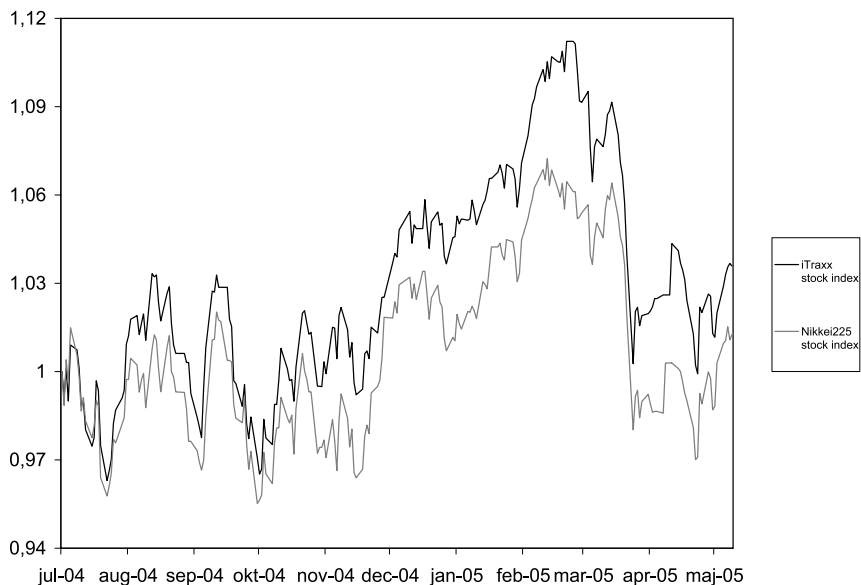


Fig. 8.3. The Inter-Temporal Movements of the “iTraxx” Stock Index and the Nikkei 225 Stock Index over the Time Period July 26, 2004–June 3, 2005

the simple sample volatility estimators. This is coming through in our results. Finally, when comparing our results to those in Byström (2005a) we find the overall results to be very similar.

3.4. Can iTraxx CJ Be Used to Hedge Market-Wide Credit Risk in Japan?

The ultimate purpose of this paper is to investigate whether the *iTraxx CJ* index can be used to hedge the market-wide credit risk in the *Nikkei 225* index. We do not expect such a hedge to be entirely “basis free” considering that the *iTraxx CJ* index is based on only 50 firms while the broad based *Nikkei 225* index represents a portfolio of 225 firms. Still, however, no other methods are really available for an investor who wants to protect himself against the credit risk exposure of a widely dispersed portfolio in Japan (or any other country) and the hedging efficiency of the *iTraxx CJ* index is therefore not only of academic interest.

The first step in our attempt to answering whether the *iTraxx CJ* market can be used for this purpose is to look at the co-movements of the portfolio of stocks in the *iTraxx CJ* index, i.e. the “iTraxx” stock index, and the overall Japanese stock market portfolio. We proxy the overall market with the *Nikkei 225* index and

Figure 8.3 shows the inter-temporal movements of the two stock indexes over the time period July 26, 2004–June 3, 2005. Obviously, the two indexes move more or less in tandem, at least in the medium- to long run, which is also indicated by the very high correlations between the levels (0.96) and between the changes (0.87). Table 8.2 further demonstrates the similarity of various statistical properties of the two indexes, and, finally, if we compare volatility estimates for the two stock indexes we find correlations between the two indexes' volatility time series to range from 0.93 to 0.98 for the various estimates. In other words, the collection of stocks in the *iTraxx CJ* index seems to be something of a mini-universe of the entire Japanese stock market and this supports the idea that the *iTraxx CJ* index can be used for market-wide credit risk protection in Japan.

We therefore turn to Table 8.3 again and repeat all the correlation calculations in the previous subsection but with the “*iTraxx*” stock index replaced with the *Nikkei 225* index. The results are presented in Table 8.3 and they strongly support the hypothesis that the *iTraxx CJ* index can be used to hedge market-wide credit risk in Japan. The correlations for the *Nikkei 225* index are overall very similar to those for the “*iTraxx*” index. The link between the CDS index spread and the volatility of the *Nikkei 225* index is slightly weaker than that between the CDS index spread and the volatility of the “*iTraxx*” stock index but the remaining links (levels, contemporaneous changes and lagged changes) between the entire stock market, i.e. the *Nikkei 225* index, and the most liquid part of the CDS market, i.e. the *iTraxx CJ* index, are essentially identical to those we found for the narrower “*iTraxx*” index. Furthermore, Figure 8.4 shows the *iTraxx CJ* CDS spread and the *Nikkei 225* index normalized to start at one in the same manner as Figure 8.2. The patterns in the two figures are very similar and this, again, confirms the earlier conclusion that the *iTraxx CJ* index can be used to protect against credit risk in market-wide stock portfolios. Or in other words, investors in Japan now seem to have a quick, cheap and easy way to avoid, or perhaps attract more of, the credit risk associated with investing market-wide in Japan.

4. CONCLUSIONS

The link between the credit default swap (CDS) market and the underlying stock or bond market is important to understand for anyone involved in hedging, speculation or arbitrage using CDS contracts. The relationship between the different markets has lately been studied in a range of papers from both a theoretical and an empirical point of view, and in this particular study we have tried to study the link through the use of aggregated CDS data of high quality.

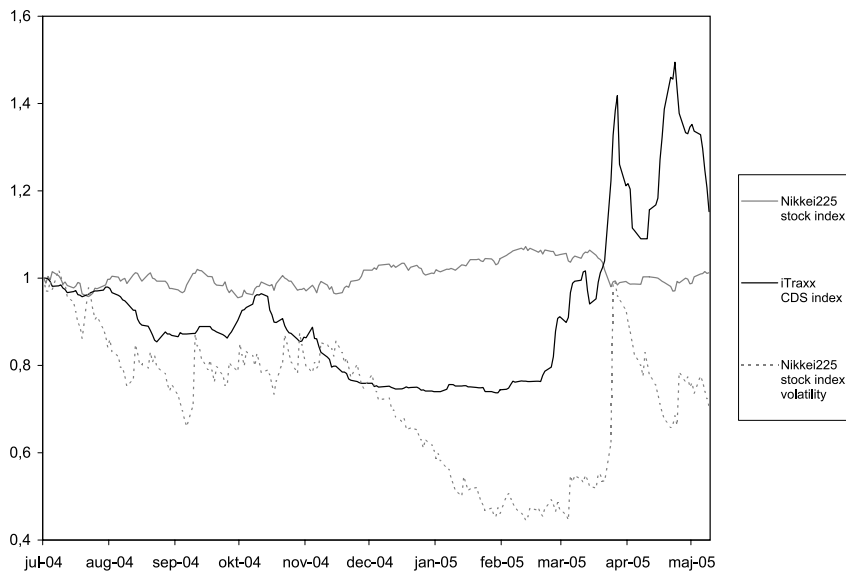


Fig. 8.4. The 5-Year *iTraxx CJ* CDS Index Spread, the *Nikkei 225* Stock Index, and the *Nikkei 225* Stock Index Return EWMA Volatility (All Normalized to Start at One) over the Time Period July 26, 2004–June 3, 2005

We have chosen to look at the Japanese *iTraxx CJ* credit default swap index market, and how this market can be used to protect against market-wide credit risk in the Japanese corporate sector. We cover the first 10–11 months after the launch of the index, i.e. the time period July 26, 2004–June 3, 2005. Furthermore, since this probably is the first study dealing with the *iTraxx CJ* market we also present some descriptive statistics on the spreads and spread changes in this market. The most important finding is that the *iTraxx CJ* index is highly correlated not only with a stock portfolio made up of the 50 names in the *iTraxx CJ* CDS index itself, but also with the much broader *Nikkei 225* stock index. Theory (Merton, 1974) tells us that a firm's default risk is related to the stock market valuation of the firm as well as the firm's stock volatility, and we find both the *Nikkei 225* index value and its volatility to be correlated with the *iTraxx CJ* credit default swap index. We take this as evidence of the Japanese *iTraxx CJ* market actually functioning as a possible (proxy) hedge against overall Japanese credit risk. Finally, even though the purpose of this paper was to investigate the *iTraxx CJ* index from the perspective of it serving as a hedging tool we would like to conclude with stressing that in addition to serving as a useful market for risk managers, the liq-

uid Japanese CDS index market should also be seen as a practical trading tool for all other investors.

ACKNOWLEDGEMENT

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Chapter 9

THE DISTRIBUTION OF YEN DENOMINATED CREDIT SPREADS

Craig A. Ellis and Warren Hogan

Abstract

The credit spread represents the difference in the yields between different risk or ratings classes of securities with the same maturity. The objective of this study is to provide an understanding of the distributional qualities of credit spreads between different risk and maturity classes of Yen denominated Eurobonds. Yen denominated Eurobonds represent the largest market segment after U.S. dollar denominated issues. We begin by first measuring the moments of the distributions of the credit spread series, and then examine different distributional models which may be consistent with the observed spread distributions. Our results provide strong evidence in favour of the yen credit spread series conforming to a mixture of two Normal distributions. The implications of these results for credit risk management are also discussed.

1. INTRODUCTION

The credit spread represents the difference in the yields between different risk or ratings classes of securities with the same maturity. Credit spreads underpin the pricing of credit derivatives, a relatively new class of derivative asset which among other applications, may be used to transfer credit risk between counterparties. Credit spread derivatives and trading involves establishing the margin between the return on one rating of bond and, most usually the risk-free return on a government bond. The essence of the credit spread contract is the relative margin at maturity between the two bonds.

The credit derivatives market is arguable one of the fastest growing financial markets. In their 1997/98 survey the British Bankers Association estimate the

size of the credit derivatives market at US\$180 billion. The predicted value of the market by the end of 2006 is US\$8.4 trillion—a 47 fold increase since the 1997/98 survey. Associated with the dramatic increase in the size of the credit derivatives market are increases in both the number of different credit derivative assets available and the proportion of derivative assets written against non-sovereign assets (BBA Credit Derivatives Report 2003/2004). The growth of the market and variety of credit derivative assets being traded means it is important that the underlying characteristics of credit spreads themselves are well understood.

The focus of this study is the distribution of credit spreads between AAA and AA rated¹ yen denominated Eurobonds and the equivalent Japanese Government bonds. We consider maturities of 2-, 3-, 5-, 7-, 10- and 20-years for the period from 9 January 1993 to 21 October 1998. Japanese government bond issues are traditionally at a fixed rate with maturities from 2-years to 20-years, though most domestic market issues have a maturity of 10-years (Batten, Hogan and Pynnonen, 1999). In 1998 the Japanese government bond market had outstanding bonds worth 2987.7 billion USD, making it the largest domestic bond market after that of the United States worth 7441.6 billion USD (BIS, 1999). While government issues dominate the Japanese domestic bond market the reverse is true in yen denominated Eurobond markets which are made up largely of private sector issues. Japanese government issues in Eurobond markets normally are for maturities of 10-years to 20-years while private sector issues by high-grade sovereign or supranational issuers tend to have maturities of 2-, 3- and 5-years. The yen denominated Eurobond market in 1998 comprised 407.1 billion USD outstanding, making it also the second largest market after the US dollar market, comprising 1673.4 billion USD outstanding (BIS, 1999).

Previous studies of credit spreads have focused largely on the term structure of credit using first structural models derived from Merton (1974), and later using reduced-form models introduced by Duffie and Singleton (1997). A comprehensive review of studies using both types of model is given in Meng and Gwilym (2005). Recent studies evaluating forecasts of credit spreads and of spread volatility include Sueppel (2005) and Johnson and Batten (2003). The distribution of US credit spreads is considered by Pedrosa and Roll (1998) and of AUD denominated spreads by Phoa (1999) however comparatively little is known about the distribution of yen denominated spreads.

¹ Bond credit rating agencies categorise corporate bond issuers into nine major classes according to perceived credit quality. These ratings classes include investment grade issuers: AAA, AA, A and BBB, and non-investment grades: BB, B, CCC, CC, and C. Bonds with ratings below C are bonds in default or of bankrupts. The two major agencies use slightly different notation to refer to equivalent credit risk categories. Standard & Poor's use upper-case capitals (e.g., AAA), while Moody's Investor Services use an upper case first character and have any remaining characters lower case (e.g., Aaa). This paper uses the Standard & Poor's notation.

The primary objective of this study is to provide an understanding of the distributional qualities of yen denominated credit spreads. We begin by first measuring the moments of the distributions of the various credit spread series, and then examine different distributional models which may be consistent with the observed spread distributions. Our results provide strong evidence in favour of the yen credit spread series conforming to a mixture of two Normal distributions. The rest of the paper is structured as follows. Section 2 following defines how credit spreads are calculated in this study and the component data used to construct the credit spread series. Section 3 then examines the distribution of credit spreads and credit spread changes. A brief discussion of Japanese bond yields during the sample period is also provided. Empirical analysis of alternative models for determining what type of distribution the credit spread series may conform to is provided in Section 4. Section 5 concludes.

2. CREDIT SPREADS DEFINED

The credit spread is the difference in the yields between different risk or ratings classes of interest bearing securities with the same maturity. Knowledge of the underlying distributional qualities of credit spread data is important for credit spread traders and sellers of credit spread options to ensure that correct pricing decisions are made. Of particular concern is the distribution of the spread and of interday spread changes and its four moments (mean, standard deviation, skewness and kurtosis) since most market valuation models—for instance simple option pricing models—assume the distributions are Normal. Risk managers may also be interested in the confidence intervals surrounding the moments of the distribution for Value-at-Risk purposes. To provide an insight into these issues, we consider the distribution of yield spreads, representing credit rating premiums, between different ratings classes of yen denominated Eurobonds and Japanese government bonds.

The data employed in this study comprises aggregated bond yields for two different ratings classes of yen denominated Eurobonds (AA and AAA rated) and government bonds with maturities of 2-, 3-, 5-, 7-, 10- and 20-years over the period 9 January 1993 to 21 October 1998—a total of 1382 observations for each bond issue. Since Eurobonds are largely unsecured most Eurobond issues are by high quality issuers with AA and AAA ratings being the most liquid. Following from Duffee (1998) our analysis excludes bonds with embedded options such as callable, puttable, or convertible bonds. The bond yield data is provided by the Westpac Banking Corporation and is collected as a weighted average daily

yield for each credit rating across three to four industrial sectors. The sectors include Industrial, Telecommunications, Banking and Finance, Utilities, Cable and Broadcasting. While this approach to data collection may be biased by cross-sectional variation across industry sectors such as that observed by Longstaff and Schwartz (1995) and Duffee (1998), not averaging the yields alternatively introduces concern over the liquidity of the bonds of some industry sectors given that the majority of bonds are issued by the banking and finance industries. While therefore cross-section variation cannot be entirely excluded, a review of the data collection process employed by Longstaff and Schwartz, and Duffee shows both studies rely on industry aggregates with a mix of maturities, such that so some of the observed variation may have been introduced through differences in the average maturity of bonds issued by the different industry sectors.

The bond yields themselves represent benchmark yields interpolated from secondary market prices using cubic splining methods. Whereas linear interpolation between observed yields produces a forward curve which is not smooth in its first or second derivation, cubic splining has the advantage that it produces a zero curve which is both smooth in its first derivation and continuous in the second order derivatives. Studying yield spreads calculated from estimated zero curves is important in that it avoids coupon bias where for example, dependent on the dollar value of coupons, bonds with the same maturity will not necessarily have equal durations nor convexities (Duffee, 1998; Lubochinsky, 2002).

Following from Manzoni (2002) continuously compounded credit spreads in this study are calculated as

$$CS_t = \ln(1 + r_t^{\text{NG}}) - \ln(1 + r_t^{\text{JGB}}) \quad (1)$$

where CS_t is the spread at time t , r_t^{NG} is the yield on the non-government issued bond at time t , r_t^{JGB} is the yield on the Japanese government issued bond at time t , and $\ln$ is the natural logarithm. This specification of the spread is preferred over the simple difference in yields $r_t^{\text{NG}} - r_t^{\text{JGB}}$ for the fact that spreads calculated by the simple difference method may be an increasing function of the benchmark yield—Japanese government bonds in our case. Additionally, the employ of the natural logarithm in Eq. (1) is thought to capture information about the nonlinear relationship between bond ratings and yields (Manzoni, 2002).

3. JAPANESE BOND YIELDS AND THE DISTRIBUTION OF YEN DENOMINATED CREDIT SPREADS

The distribution of credit spreads and changes in credit spreads is important for credit spread traders and risk managers alike. Commencing with a brief overview

of Japanese government bond and Eurobond yields during the sample period, this section focuses on the distributional qualities of yen denominated credit spreads, and to a lesser extent changes in credit spreads.

3.1. Japanese Government bond and Eurobond Yields

Bond yields generally fell over the sample period. 20-year Japanese government bond yields for instance fell from near 5.8% in June 1993 to below 2.0% in October 1998. During the sample period the credit spread on the 20-year AAA bond was generally positive though there were two prolonged periods when the 20-year AAA Eurobond yield was below the equivalent maturity Japanese government bond: from September 1993 to September 1994, and June 1995. The latter period of negative 20-year AAA spreads is associated with extensive Japanese central bank intervention in response to appreciation of the USD against the yen following record low levels, resulting in a slight increase in 20-year yields. The credit spread on 20-year AA bonds was also generally positive though there were again two distinct periods when the 20-year AA Eurobond yield was below the equivalent maturity Japanese government bond. With the exception of 7-year and 10-year AAA bond spreads, there are no distinct and sustained periods of negative spreads for the other maturities or credit rating.

Spreads for all maturities and both credit ratings (AA and AAA) generally narrowed over the sample period and are noticeably lower during the second half of the sample. Towards the ends of the sample period, both the 20-year AA and AAA bond yields are almost par with the 20-year Japanese government bond yield. Results with respect to 20-year AA and AAA spreads in particular may be attributed to the impact of sterilised intervention and to portfolio adjustments by international investors between different risk classes of yen Eurobonds, Japanese government bonds and non-yen denominated securities. In the period June 1993 to June 1995, Japanese central bank sterilised intervention resulted in increased government yields relative to non-government yields as more government bonds were issued, thus reducing spreads between the two bonds. Batten, Hogan and Pynnonen (1999) surmise that investors observing the declining prices of Japanese government bonds (but still preferring to hold yen denominated bonds) substituted Japanese government bonds for non-Japanese AA and AAA rated yen denominated Eurobonds. In the period of USD appreciation following June 1995 it is suggested that international investors taking long USD/short yen positions simultaneously sold yen bonds though it is likely that these investors preferred to sell Eurobonds than Japanese government bonds. The credit spreads consequently rose. The later increase in the spreads with the spike in yields in 1997, may be seen to be associated with the then immanent collapse of Japanese financial insti-

tutions (Miyanoya, 1999) and a “flight to quality” to Japanese government bonds. The increase in the credit spreads on AA and AAA bonds reflected the premium demanded by investors on the Eurobonds issued by Japanese financial institutions or other institutions with credit exposure to Japanese institutions. The decline in these risks due to Japanese government support of the banking sector, and the lack of central bank intervention to support the USD finally resulted in a narrowing of the spread.

3.2. Yen Denominated Credit Spreads

The distribution of AA yen denominated credit spreads versus the Normal distribution is given in Figure 9.1, and for AAA yen denominated credit spreads in Figure 9.2. Summary statistics for AA and AAA credit spreads of yen denominated Eurobonds are reported in Table 9.1.

The overall results are consistent with the findings of Longstaff and Schwartz (1995) and Duffee (1998) in that the mean of the credit spreads declines with an increase in the quality of the credit rating. For instance the AA rated 2-year mean spread in Table 9.1 is 0.0018 while for AAA rated 2-year bonds the mean spread is 0.0012. At the long end, AA rated 20-year bonds have a mean spread of 0.0018, while for the equivalent maturity AAA rated bond the spread is only 0.0005. The results suggest, furthermore, that high-grade credit spreads increase with increasing maturity from 2-years to 3-years, but decrease thereafter. Mean spreads for AA rated bonds likewise increase from maturities of 2-years to 3-years, but fluctuate thereafter. Median credit spreads for all maturities are likewise higher for AA rated bonds than for AAA rated bonds and show variability after an initial increase with increasing maturity from 2-years to 3-years. These results suggest a humped shaped term structure of the credit spreads for yen denominated bonds which is broadly consistent with prior empirical studies on credit spreads (see for example Fons, 1994). The humped credit curves for the AA and AAA issuers are however inconsistent with the upward sloping curve predicted by Merton (1974) and Jarrow, Lando and Turnbull (1997) for high grade issuers.

The standard deviation of the credit spread tends to increase with a declining credit rating, although this relationship is not uniform across all maturities. For instance AA rated 2-year bond spreads have a standard deviation of 0.0016 and AAA rated 2-year bond spreads a slightly lower standard deviation of 0.0013. The standard deviation of AA rated 20-year bond spreads (0.0019) is however less than the standard deviation of AAA rated 20-year bond spreads (0.0022). The findings are again consistent with a humped shaped yield curve for AA and AAA yen denominated Eurobond spreads. With the exception of 20-year AA and AAA credit spreads, all of the AA and AAA spread series display excess kurtosis

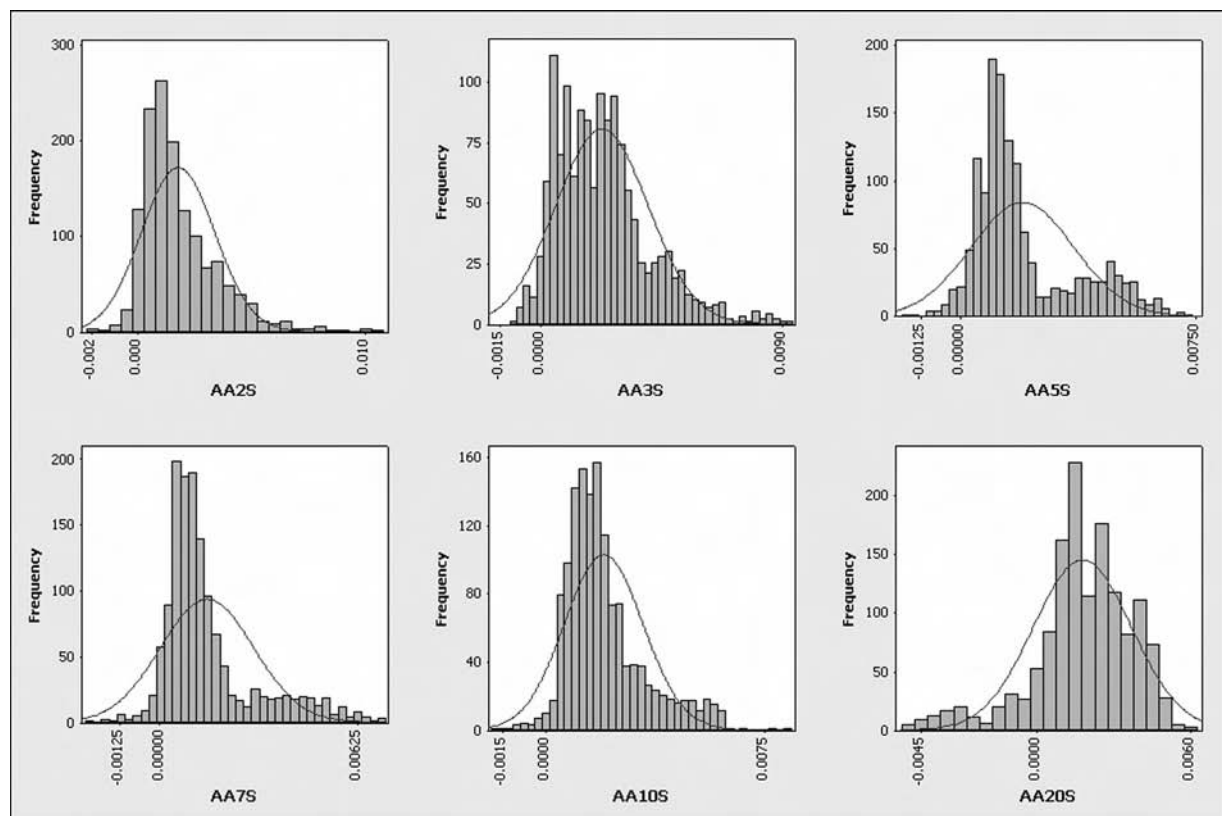


Fig. 9.1. Distribution of AA Credit Spreads

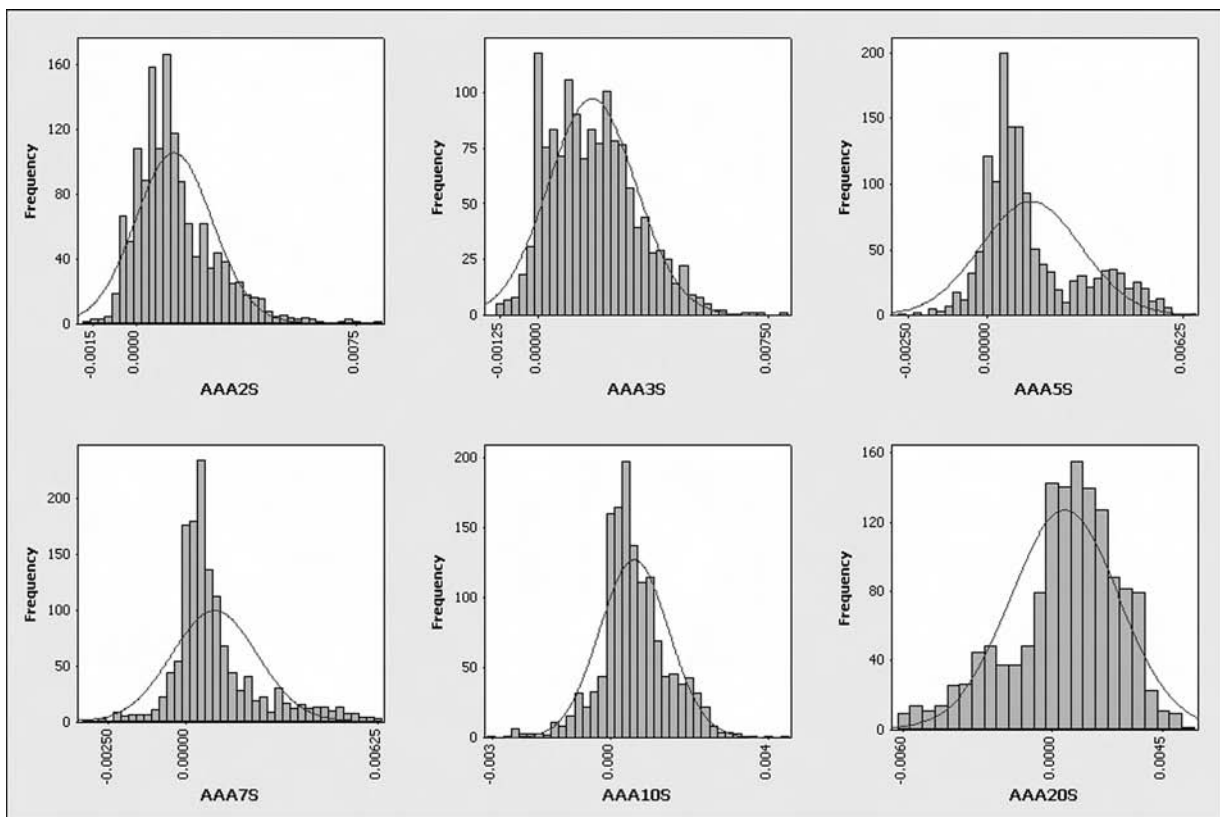


Fig. 9.2. Distribution of AAA Credit Spreads

Table 9.1
Summary Statistics of AA and AAA Credit Spreads

	AA2S	AA3S	AA5S	AA7S	AA10S	AA20S
Mean	0.0018	0.0023	0.0020	0.0015	0.0020	0.0018
Median	0.0013	0.0021	0.0014	0.0010	0.0017	0.0018
Standard Deviation	0.0016	0.0017	0.0016	0.0015	0.0013	0.0019
Skewness	1.3962	0.9711	1.0803	1.4900	1.1554	-0.9315
Kurtosis	2.8084	1.1019	0.2789	1.8882	1.4619	1.3501
98% Confidence Intervals						
Mean (lower)	0.0017	0.0022	0.0019	0.0014	0.0019	0.0017
(upper)	0.0019	0.0024	0.0020	0.0016	0.0021	0.0019
Median (lower)	0.0012	0.0020	0.0013	0.0010	0.0016	0.0017
(upper)	0.0015	0.0023	0.0015	0.0011	0.0018	0.0020
Minimum	-0.0018	-0.0009	-0.0019	-0.0022	-0.0016	-0.0052
Maximum	0.0107	0.0091	0.0073	0.0070	0.0083	0.0058
Sum	2.4330	3.1726	2.6998	2.0332	2.7302	2.4450
Anderson-Darling (<i>p</i> -value)	<0.0500	<0.0500	<0.0500	<0.0500	<0.0500	<0.0500
Ryan-Joiner (<i>p</i> -value)	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
	AAA2S	AAA3S	AAA5S	AAA7S	AAA10S	AAA20S
Mean	0.0012	0.0018	0.0014	0.0009	0.0006	0.0005
Median	0.0010	0.0017	0.0009	0.0006	0.0005	0.0009
Standard Deviation	0.0013	0.0014	0.0016	0.0014	0.0009	0.0022
Skewness	1.1718	0.5426	0.9742	1.3306	-0.0002	-0.6790
Kurtosis	2.0602	0.0777	0.1917	2.2466	1.4724	0.2131
98% Confidence Intervals						
Mean (lower)	0.0012	0.0017	0.0013	0.0008	0.0006	0.0004
(upper)	0.0013	0.0019	0.0015	0.0010	0.0007	0.0007
Median (lower)	0.0009	0.0015	0.0008	0.0005	0.0005	0.0006
(upper)	0.0011	0.0018	0.0009	0.0006	0.0006	0.0010
Minimum	-0.0017	-0.0012	-0.0028	-0.0033	-0.0030	-0.0062
Maximum	0.0082	0.0081	0.0064	0.0062	0.0044	0.0053
Sum	1.7242	2.4413	1.8989	1.2719	0.8364	0.7175
Anderson-Darling (<i>p</i> -value)	<0.0500	<0.0500	<0.0500	<0.0500	<0.0500	<0.0500
Ryan-Joiner (<i>p</i> -value)	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100

and positive skewness. Characteristic of the above described relationship between 20-year AA and AAA rated bonds and 20-year Japanese government bonds during the sample period, both 20-year AA and AAA spreads exhibit negative skewness.

Upper and lower limits for the 98% confidence interval about the mean and median for AA and AAA rated credit spreads are also provided in Table 9.1. Analysis

of the frequency of spreads outside the 98% confidence interval provides one indication of the overall fit of the Normal distribution using which, only 1% of values should be greater (less than) the upper (lower) confidence bounds. On average, approximately 95.2% of all AA rated spread values over the full sample period are outside the 98% confidence interval for the mean. For the median, this figure is approximately 92.7%. On average, approximately 58.9% of spread values fall below the lower limit for the mean and 36.5% above the mean. Corresponding figures for the median are approximately 47.8% (below) and 45.1% (above), respectively. For AAA rated spreads, approximately 93.7% of all values lay outside the outside the 98% confidence interval for the mean and 93.6% for the median. The dispersion above and below the upper and lower limits for AAA rated spreads is comparable to that for AA rated spreads. As for the AA rated spreads, there is no apparent relation between maturity and the dispersion above and below the upper and lower limits.

The distribution of credit spread changes, $CS_t - CS_{t-1}$ is presented in Table 9.2. Relative to the spread levels in Table 9.1, mean spread changes are not significantly different to zero. We observe similar behaviour to the spread levels with respect to the mean spread changes being closer to zero and standard deviations being lower for AAA rated spread changes. Observed levels of kurtosis are however significantly higher for spread changes than for the spread levels. Analysis with respect to the 98% confidence interval reveals on average approximately 40.2% of all AA spread changes and 40.4% of all AAA spread changes are above the upper limit for the mean and approximately 40.1% of all AA spread changes and 40.2% of all AAA spread changes fall below the lower limit. That is over 80% of all AA and AAA rated spread changes fall outside the 98% confidence interval for the mean.² Anderson–Darling and Ryan–Joiner test p -values in Table 9.2 reject the Normal null for all the spread change series. These results have particular implications for risk managers using standard statistical measures based on the Normal distribution to determine the frequency that credit spread or credit spread changes will lie outside the 98% confidence interval for Value-at-Risk purposes, namely the inappropriate use of the Normal distribution. The implications of non-Gaussian distributions for managing credit spread risk are discussed in more detail by Pedrosa and Roll (1998) and Phoa (1999). Of interest to the findings of both studies is that significant levels of positive correlation between credit spread series of the same risk class but with different maturities, identified by Batten, Hogan and Pynnonen (1999) implies that yen denominated spread portfolios will behave in a manner similar to the individual spread series.

² Information on the dispersion of individual maturities above and below the upper and lower limits for the mean and median, as well as information on the dispersion of changes in the spread for individual maturities are available from the authors on request.

Table 9.2
Summary Statistics of AA and AAA Credit Spread Changes

	AA2S	AA3S	AA5S	AA7S	AA10S	AA20S
Mean	-4.7E-06	-5.7E-06	-4.4E-06	-3.2E-06	-2.6E-06	-2.0E-06
Standard Deviation	5.5E-04	5.5E-04	5.6E-04	6.0E-04	5.6E-04	6.0E-04
Skewness	-0.0152	0.0177	-0.1468	-0.0974	0.1510	0.1916
Kurtosis	10.8816	6.4966	4.7096	5.7515	9.0876	12.7932
98% Confidence Intervals Mean						
(lower)	3.0E-05	2.9E-05	3.1E-05	3.4E-05	3.3E-05	3.5E-05
(upper)	-4.0E-05	-4.0E-05	-3.9E-05	-4.1E-05	-3.8E-05	-3.9E-05
Minimum	-0.0045	-0.0033	-0.0033	-0.0034	-0.0034	-0.0046
Maximum	0.0039	0.0034	0.0030	0.0037	0.0045	0.0045
Sum	-0.0066	-0.0079	-0.0060	-0.0045	-0.0036	-0.0028
Anderson-Darling (<i>p</i> -value)	<0.0500	<0.0500	<0.0500	<0.0500	<0.0500	<0.0500
Ryan-Joiner (<i>p</i> -value)	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
	AAA2S	AAA3S	AAA5S	AAA7S	AAA10S	AAA20S
Mean	-2.7E-06	-2.8E-06	-3.0E-06	-2.6E-06	-9.6E-07	-2.0E-07
Standard Deviation	5.3E-04	5.3E-04	5.5E-04	6.2E-04	5.5E-04	5.9E-04
Skewness	0.1711	0.2576	0.0421	-0.1651	-0.2115	-0.1534
Kurtosis	11.3205	7.3138	5.2493	5.9076	6.0249	10.3805
98% Confidence Intervals Mean						
(lower)	3.0E-05	3.0E-05	3.2E-05	3.6E-05	3.4E-05	3.7E-05
(upper)	-3.6E-05	-3.6E-05	-3.8E-05	-4.1E-05	-3.6E-05	-3.7E-05
Minimum	-0.0048	-0.0030	-0.0034	-0.0034	-0.0037	-0.0046
Maximum	0.0037	0.0034	0.0034	0.0036	0.0034	0.0038
Sum	-0.0038	-0.0038	-0.0042	-0.0035	-0.0013	-0.0003
Anderson-Darling (<i>p</i> -value)	<0.0500	<0.0500	<0.0500	<0.0500	<0.0500	<0.0500
Ryan-Joiner (<i>p</i> -value)	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100

Returning to the analysis of spread levels Normality plots for AA rated credit spreads are provided in Figure 9.3 and for AAA rated spreads in Figure 9.4. Two formal tests for Normality are also performed: Anderson-Darling and Ryan-Joiner, the *p*-values for which are reported in Table 9.1. For series conforming to a Normal distribution, the Anderson-Darling plot of observed versus Normal probabilities will fall along the diagonal line at all levels. Deviations above or below the line indicate that the series under observation does not conform to a Nor-

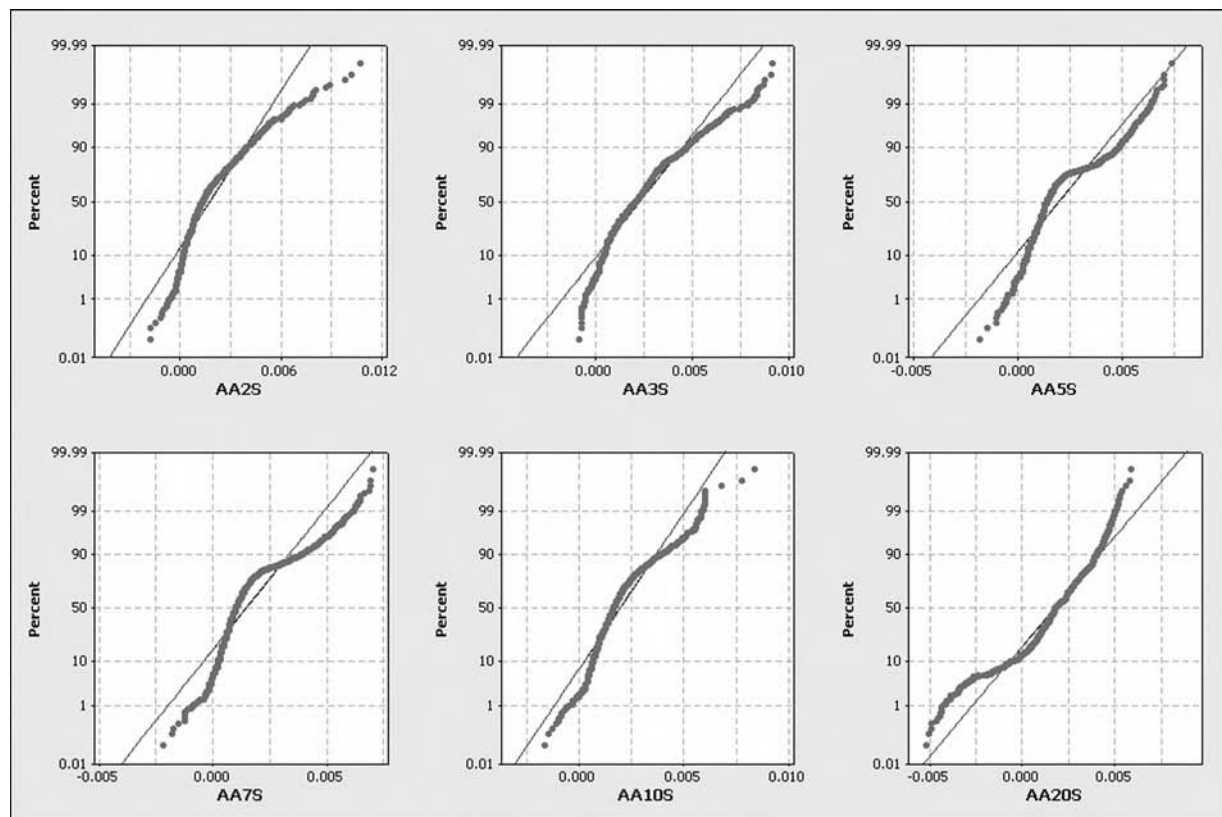


Fig. 9.3. Normal Probability Plot of AA Credit Spreads

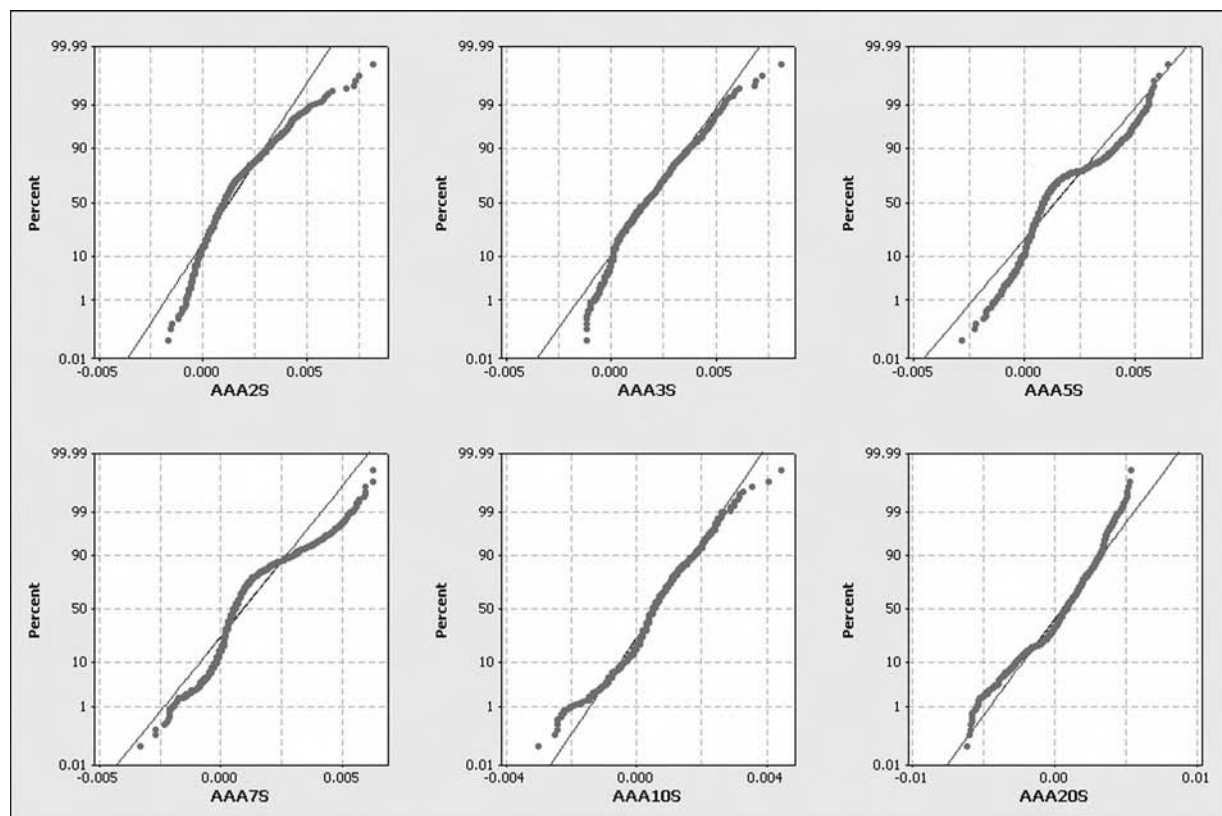


Fig. 9.4. Normal Probability Plot of AAA Credit Spreads

mal distribution. Symmetric yet heavy-tailed distributions are characterised by deviations above the line at low probabilities and below the line at high probabilities. Symmetric light-tailed distributions exhibit the opposite pattern of behaviour. Characteristic of significant positive skewness, the probability plots of 2-year to 10-year AA and AAA rated credit spreads generally exhibit deviations below the line at low and high probabilities, while spreads for the 20-year maturity exhibit the opposite behaviour. Only the 10-year AAA rated spread in Figure 9.4 exhibits heavy left- and right-tails. Confirming all of the above reported findings with respect to the distribution of AA and AAA credit spreads, p -values for both the Anderson–Darling and Ryan–Joiner tests in Table 9.1 reject the Normal null at the 0.05 level.

4. EXPLAINING NON-NORMALITY IN THE DISTRIBUTION OF CREDIT SPREADS

The preliminary analysis of the distribution of credit spreads in Section 3 has revealed, not surprisingly, that a stable Normal distribution provides a relatively poor fit for both daily credit spread levels and changes in credit spreads. The general failure of the stable Normality assumption can be seen to arise from two sources: the overall poor fit of the Normal curve against observed (changes) in financial asset prices (Mandelbrot, 1963; Pagan, 1996); and the instability of the probability distribution (Kearns and Pagan, 1997). Having rejected the Normal null we now turn to some alternative models of the distribution of credit spreads: a stable Paretian (power-law) model; and a mixture of two or more discrete Normal distributions.

4.1. Power-Law Distributed Models

Examining the characteristics of daily cotton prices Mandelbrot (1963) found that while independence of consecutive price changes was a close enough approximation of actual returns, the distribution was heavy-tailed. The observation led him to propose the stable Pareto–Levy class of power-law distributed models for asset returns $\Pr\{X > x\} = Cx^{-\alpha}$, for which the value of the exponent α (the tail index) is $0 \leq \alpha \leq 2$. Given that a well known feature of the Normal distribution is 98% of all price changes are contained within approximately ± 2.33 standard deviations of the mean, the significance of the stable Pareto–Levy distribution is that it allows for positive and negative price changes whose magnitude is well outside of the boundaries of the Normal curve. In opposition to the power-law model

Akgiray and Booth (1987, p. 269) however counterclaim that financial asset distributions are not as “outlier-prone as the stable [Pareto–Levy] law hypothesis implies”. Power-laws distributions for other financial time-series have been recently identified by various authors including Lux (1996), Gopikrishnan et al. (1999), Pasquini and Serva (1999), Huang (2000), Weron and Weron (2000), Matosa et al. (2004), and Yan et al. (2005). To our knowledge power-law models have not been previously fitted to credit spread data.

The power-law fit of AA rated credit spreads versus the Gaussian prediction is provided in Figure 9.5 and for AAA rated credit spreads in Figure 9.6. Importantly, rather than assuming a standard Normal distribution with zero mean and unit variance for all the credit spread series, the Gaussian prediction in the figures is derived for a Normal distribution with the observed mean and standard deviation of each series. While the figures show the log–log plot of the full raw histogram of the each series, the linear line of best fit is for the first five bins of the histogram only. This follows from Goldstein, Morris and Yen (2004) who—while advocating Maximum Likelihood Estimation techniques—show that the ‘first five bins’ method yields consistent mean estimates of the power-law exponent α .³

Preliminary examination of the log–log plot in Figure 9.5 shows an overall poor fit of the power-law model to daily AA rated credit spreads. Despite this, exponent values for AA rated spreads at all maturities do fall within the range required for a stable Pareto–Levy process ($0 \leq \alpha \leq 2$). The average exponent value for AA credit spreads using the ‘first five bins’ is approximately $\alpha = 1.23$ with 2-year AA spreads having the highest exponent ($\alpha = 1.53$) and 3-year AA rated spreads the lowest ($\alpha = 0.94$). By comparison, the power-law model for AAA rated credit spreads in Figure 9.6 exhibits both a closer graphical fit and higher exponent values for all maturities with an average exponent value $\alpha = 1.70$ and a range from $\alpha = 1.04$ (3-year) to $\alpha = 2.12$ (2-year), the latter being just outside the stable Pareto–Levy range. The high exponent value for AAA rated 10-year spreads of $\alpha = 4.08$ is however consistent with the general class of hyperbolic non-stable distribution (Zhaoxia and Gençay, 2003).

4.2. Mixture of Discrete Normal Distributions

When speaking of a mixture of discrete Normal distributions what we refer to is the underlying hypothesis that observations within a given data series belong to two or more Normal distributions each of which is characterised by a unique mean

³ Despite the higher variance of the estimate of the ‘first five bins’ over Maximum Likelihood Estimation of the exponent as also shown by Goldstein, Moris and Yen the graphical technique is preferred herein for its simplicity as a first stage approximation of the fit of the power-law distribution.

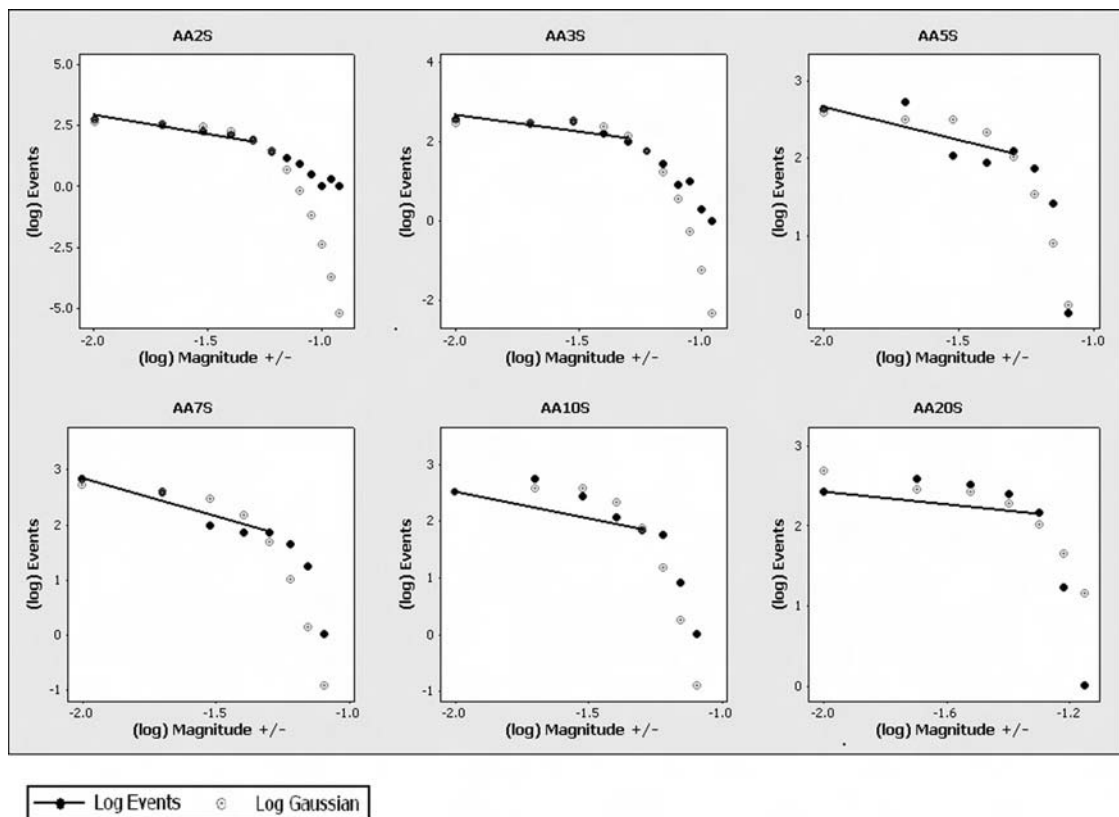


Fig. 9.5. Power-Law Fit of AA Credit Spreads

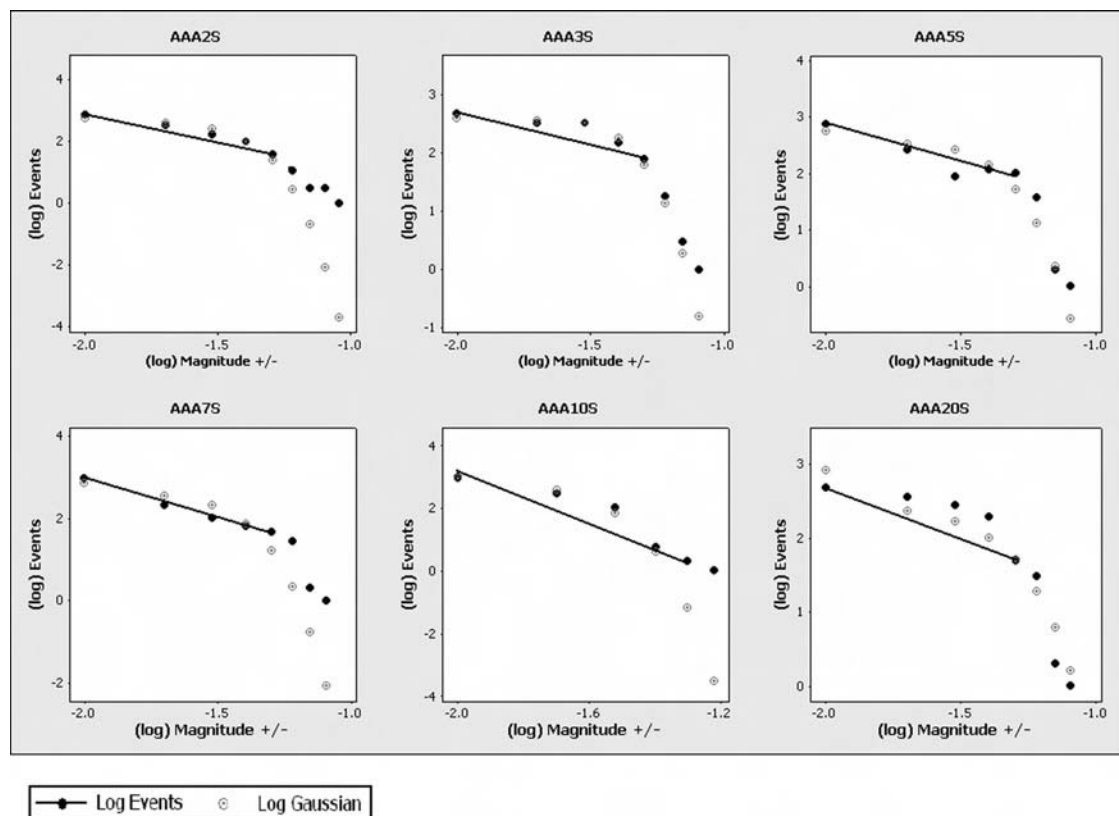


Fig. 9.6. Power-Law Fit of AAA Credit Spreads

and variance and a stable mixing proportion (i.e. the probability that a given observation belongs to a particular Normal distribution).⁴ The mixed diffusion-jump process of Merton (1982) comprising an infinite number of Normal distributions with Poisson mixing probabilities, is one form of a mixture of discrete Normal distributions model. Another general class is attributable to Kon (1984) who proposed a finite (rather than infinite) mixture of Normal distributions with general mixing probabilities. The probability density function (pdf) given a mixture of two or more Normal distributions is derived from the pdf for a single stationary Normal distribution and is

$$g(x) = \sum_{j=1}^k \lambda_j \frac{1}{\sqrt{2\pi\sigma_j^2}} \exp\left\{-\frac{(x - \mu_j)^2}{2\sigma_j^2}\right\} = \sum_{j=1}^k \lambda_j f_j(x) \quad (2)$$

where k is the number of distinct densities, $f_j(x)$ is the j th density, and λ_j is the probability of the j th density, such that $\sum_j \lambda_j = 1$. All the moments of the j th density (e.g., mean, variance) are defined as usual.

A key advantage of the mixture of Normal distributions model over distributions such as the Student- t distribution is that it may be used to capture changes in both the mean and variance (Yu, 2001). Furthermore the model can be used to explain skewness by mixing two Normal distributions with different means, and excess kurtosis by mixing two Normal distributions with different standard deviations. An example of modelling skewness and excess kurtosis from a mixture of two Normal distributions is shown in Figures 9.7 and 9.8, respectively, wherein both figures Cluster 1 comprises a standard Normal distribution with zero mean and unit variance. Cluster 2 in Figure 9.7 comprises a Normal distribution also with unit variance, but with means $-0.5 \leq \mu_2 \leq 0.5$. Cluster 2 in Figure 9.8 comprises a Normal distribution also with zero mean, but with standard deviations $1 \leq \sigma_2 \leq 2$. Mixing proportions p_1 are 0.25, 0.5 and 0.75 in both figures.

Simulation results in Figure 9.7 predict a complex non-linear relationship between the skewness of the mixed distribution, Cluster 2 means and the mixing proportion. Skewness is positively related to the mixing proportion p_1 for $0 < \mu_2$, and is negatively related for $\mu_2 < 0$. Owing to the complexity of the relationship between the variable parameters p_1 and μ_2 , negative skewness may be induced by either of a low probability of a large-negative mean, or a high probability of a large-positive mean. Alternatively, positive skewness may be induced by either a high probability of a large-negative mean, or a low probability of a large-positive

⁴ Higher order moments also exist for the mixture of discrete Normal distributions. The mixture of two Normals model may also be empirically estimated with a common mean or common variance for both distributions.

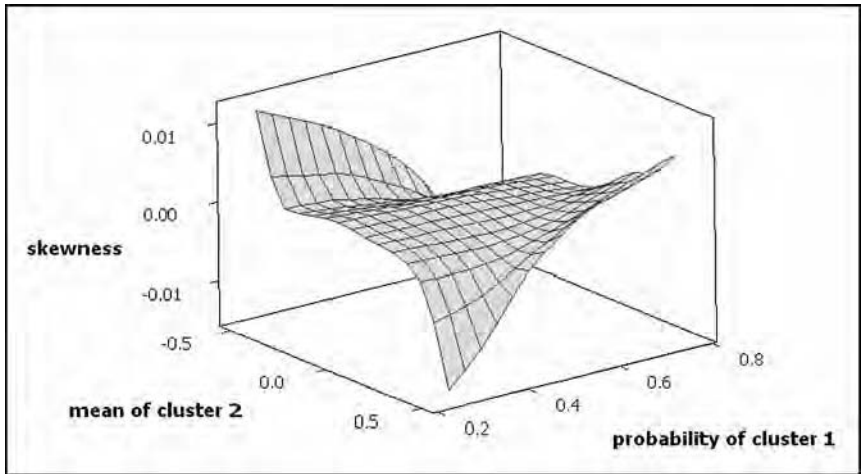


Fig. 9.7. Skewness of a Mixture of Two Normal Distributions

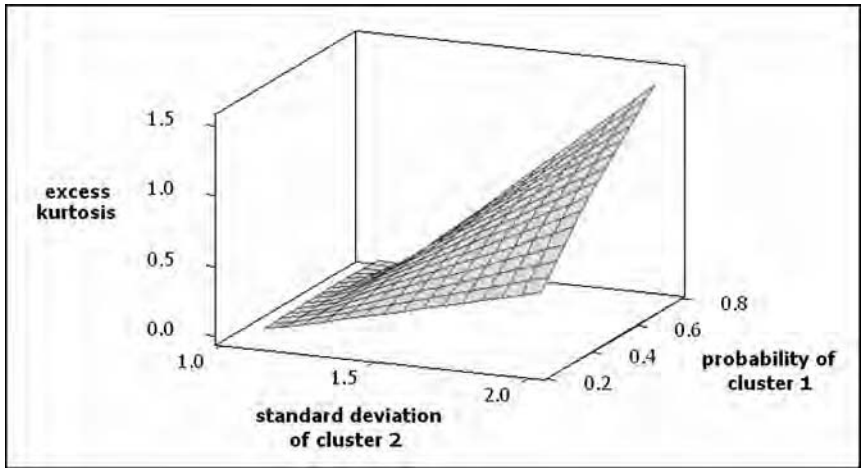


Fig. 9.8. Excess Kurtosis of a Mixture of Two Normal Distributions

mean. Excess kurtosis meanwhile in Figure 9.8 is greatest given a small probability of large standard deviation (variance). Both results are important in that they demonstrate the potential for low-probability events to induce significant levels of skewness and/or excess kurtosis in the mixed distribution. The mixture of Nor-

mal distributions may prove a likely candidate distributional model given the observed levels of both significant skewness and kurtosis in the credit spread series in this study. The mixture of discrete Normals has been previously considered for a variety of financial time-series by authors including Akgiray and Booth (1987), Tucker and Pond (1988), Kwok and Folks (1992), Lin and Yeh (2000), and for credit spreads specifically by Pedrosa and Roll (1998).

Empirical testing of the mixture of Normal distributions hypothesis is completed in this study using the Expectation Maximisation (EM) algorithm within WEKA v3.4.5, a Java based data mining package developed at the University of Waikato, New Zealand and distributed under public licence.⁵ The EM algorithm is designed to group observations from a series into unique clusters via maximisation of the log-likelihood function $l(\Theta | x)$ wherein the probability density function for the mixture of Normal distributions is defined in Eq. (2), and Θ is the parameter set most likely to have generated x . In the case of a mixture of two Normal distributions the five variable parameters of interest are λ , μ_1 , μ_2 , σ_1^2 , and σ_2^2 . The EM algorithm in WEKA selects the number of clusters automatically by default, but can also be programmed to fit a pre-specified number of Normal distributions. Beginning with one cluster the EM algorithm continues to add clusters to the point where the log-likelihood of the mixture does not significantly increase, that is to the point the descriptive power of the mixture is not improved by adding more clusters. The EM algorithm assumes that observations in the series are independent random variables.

Two mixture combinations are considered in this study: the mixture of n Normal distributions, and a mixture of two Normals only. Inclusion of the mixture of two Normals follows from Tucker (1992) who in comparing various mixture models, finds that the mixture of two Normal distributions has the highest descriptive power. Output from the EM algorithm for the mixture of n Normal distributions for AA rated credit spreads is provided in Table 9.3 and for AAA rated spreads in Table 9.4. Output pertaining to the mixture of two Normals is presented in Table 9.5 for AA and AAA rated credit spreads.

Tests for the significance in the difference between the log-likelihoods of the different mixture models are conducted using the likelihood-ratio test statistic

$$\Lambda = -2 \ln \left(\frac{L(\hat{\Theta}_r | x)}{L(\hat{\Theta} | x)} \right) = -2 [l(\hat{\Theta}_r | x) - l(\hat{\Theta} | x)] \quad (3)$$

where $l(\hat{\Theta}_r | x)$ is the log-likelihood of the reduced model and $l(\hat{\Theta} | x)$ is the log-likelihood of the full model. Denoting k to be the number of additional para-

⁵ WEKA is available for download at <http://www.cs.waikato.ac.nz/ml/weka>.

Table 9.3
AA Credit Spreads—Mixture of n Normal Distributions via EM Algorithm

	AA2S	AA3S	AA5S	AA7S	AA10S	AA20S
Prior Probability (1)	0.6045	0.4173	0.7479	0.5101	0.4790	0.2248
Mean	0.0008	0.0026	0.0011	0.0007	0.0013	0.0015
Std Dev	0.0006	0.0007	0.0006	0.0004	0.0005	0.0004
Instances	65%	45%	77%	58%	63%	26%
Prior Probability (2)	0.3654	0.4075	0.2521	0.2271	0.4532	0.2129
Mean	0.0030	0.0008	0.0045	0.0014	0.0022	0.0026
Std Dev	0.0012	0.0006	0.0010	0.0005	0.0012	0.0004
Instances	33%	41%	23%	22%	32%	25%
Prior Probability (3)	0.0301	0.1098		0.0979	0.0678	0.2597
Mean	0.0064	0.0047		0.0035	0.0053	0.0040
Std Dev	0.0023	0.0005		0.0009	0.0005	0.0006
Instances	2%	8%		11%	5%	20%
Prior Probability (4)		0.0653		0.0850		0.1933
Mean		0.0061		0.0051		0.0008
Std Dev		0.0016		0.0008		0.0006
Instances		6%		7%		19%
Prior Probability (5)				0.0800		0.0521
Mean				0.0009		−0.0011
Std Dev				0.0011		0.0005
Instances				2%		5%
Prior Probability (6)						0.0572
Mean						−0.0035
Std Dev						0.0007
Instances						5%
Log-Likelihood	5.1742	5.0713	5.2517	5.4094	5.3425	4.9544

meters in the full model the likelihood-ratio, Λ is χ^2 distributed with k degrees of freedom. A variant of the likelihood-ratio test in Eq. (3) is employed by Pedrosa and Roll (1998) to test the whether credit spreads changes for U.S. corporate bonds are best modelled by a single Normal distribution or a mixture of Normal distributions.

Preliminary analysis of the EM algorithm output in Tables 9.3 and 9.4 suggests that none of the credit spread series can be best described by a single Normal distribution. For AA rated spreads in Table 9.3, the number of clusters (Normal distributions) identified by the EM algorithm ranges from two for the 5-year maturity, to six for the 20-year maturity when using the full model with no a priori restrictions on the number of clusters. For AAA rated spreads in Table 9.4 the

Table 9.4

AAA Credit Spreads—Mixture of n Normal Distributions via EM Algorithm

	AAA2S	AAA3S	AAA5S	AAA7S	AAA10S	AAA20S
Prior Probability (1)	0.5210	0.7627	0.4832	0.5587	0.4305	0.4023
Mean	0.0005	0.0022	0.0006	0.0004	0.0003	0.0024
Std Dev	0.0006	0.0014	0.0005	0.0004	0.0003	0.0010
Instances	68%	72%	58%	67%	54%	40%
Prior Probability (2)	0.2987	0.2373	0.2269	0.3297	0.3208	0.3741
Mean	0.0025	0.0004	0.0040	0.0009	0.0004	0.0004
Std Dev	0.0009	0.0005	0.0009	0.0012	0.0011	0.0007
Instances	27%	28%	22%	25%	17%	37%
Prior Probability (3)	0.0418		0.2900	0.1116	0.1249	0.2235
Mean	−0.0004		0.0008	0.0041	0.0010	−0.0024
Std Dev	0.0001		0.0010	0.0010	0.0002	0.0016
Instances	3%		20%	8%	15%	23%
Prior Probability (4)	0.0244				0.1237	
Mean	0.0049				0.0018	
Std Dev	0.0017				0.0004	
Instances	1%				14%	
Prior Probability (5)	0.1141					
Mean	0.0011					
Std Dev	0.0004					
Instances	1%					
Log-Likelihood	5.3210	5.1842	5.2077	5.4082	5.6532	4.7569

range is from two (3-year maturity) to five (2-year maturity) clusters. There is no apparent relationship between the number of clusters and either the maturity or the rating level of the spreads. The difference in mixing proportions (Instances) for spreads with fewer clusters is typically large, as is the difference in the means for each cluster, however differences in both the mixing proportions and the moments of the distributions are generally less the greater the number of clusters. This and the fact also that mixing proportions for the lowest ranking clusters (i.e. those with the lowest mixing proportions) for each spread series in Tables 9.3 and 9.4 are 5% or less when the number of clusters is more than two, suggests that the EM algorithm with no a priori restrictions may tend to ‘overfit’ the data and that fixing the number of clusters to two for each series (as per Tucker, 1992) will not significantly reduce the descriptive power of the model.

Statistics pertaining to the mixture of two Normal distributions for AA and AAA rated credit spreads is presented in Table 9.5. Relative to the simulated findings presented in Figure 9.7 and discussion thereof, the results in Table 9.5

Table 9.5

AA and AAA Credit Spreads—Mixture of Two Normal Distributions via EM Algorithm

	AA2S	AA3S	AA5S	AA7S	AA10S	AA20S
Prior Probability (1)	0.5564	0.6474	0.7479	0.8054	0.8266	0.9299
Mean	0.0008	0.0015	0.0011	0.0009	0.0015	0.0022
Std Dev	0.0006	0.0011	0.0006	0.0006	0.0008	0.0015
Instances	64%	79%	77%	82%	84%	95%
Prior Probability (2)	0.4436	0.3526	0.2521	0.1946	0.1734	0.0701
Mean	0.0029	0.0038	0.0045	0.0041	0.0043	−0.0031
Std Dev	0.0018	0.0018	0.0010	0.0012	0.0011	0.0010
Instances	36%	21%	23%	18%	16%	5%
Log-Likelihood	5.1803	5.0545	5.2517	5.3790	5.3476	4.9458
	AAA2S	AAA3S	AAA5S	AAA7S	AAA10S	AAA20S
Prior Probability (1)	0.6272	0.7627	0.7496	0.6684	0.6299	0.8614
Mean	0.0006	0.0022	0.0006	0.0004	0.0007	0.0012
Std Dev	0.0007	0.0014	0.0006	0.0005	0.0010	0.0015
Instances	73%	72%	77%	74%	53%	84%
Prior Probability (2)	0.3728	0.2373	0.2504	0.3316	0.3701	0.1386
Mean	0.0024	0.0004	0.0038	0.0021	0.0004	−0.0032
Std Dev	0.0014	0.0005	0.0010	0.0019	0.0003	0.0013
Instances	27%	28%	23%	26%	47%	16%
Log-Likelihood	5.3323	5.1842	5.1762	5.4046	5.6534	4.7644

are largely consistent with the proposition that positive (negative) skewness may be induced by the low probability of a high (low) mean. Except for AAA rated 3-year spreads, all of the positively skewed spread series from Table 9.1 exhibit low probability clusters with relatively higher means than the high probability cluster in Table 9.5. Examining 7-year AA rated spreads (skewness = 1.4900) in Table 9.5 for instance, the mean of the high probability (82%) cluster is 0.0009, while for the low probability (18%) cluster the mean is 0.0041. Negatively skewed 20-year maturity AA rated spreads are alternatively characterised by a low probability (5%) cluster with a lower mean (−0.0031) than the high probability cluster mean (0.0022). 20-year AAA rated spreads, also negatively skewed, are similarly characterised.

The higher standard deviation of low probability clusters in Table 9.5 is furthermore consistent with the early discussed nature of excess kurtosis given a mixture of two Normal distributions. In the case of 2-year AA rated spreads with excess kurtosis from Table equalling 2.81, the standard deviation of the lower probability (36%) cluster is 0.0018 and for the high probability cluster is only 0.0006.

Consistent finally with Tucker (1992) differences in the log-likelihoods for the full model and the restricted model with two Normal distributions only, as measured by the likelihood ratio in Eq. (3) are not significant, suggesting no loss in descriptive power by restricting the EM algorithm to a mixture of two Normal distributions.

5. CONCLUDING REMARKS

This study extends empirical research on the behaviour of credit spreads to the yen Eurobond market by providing an in depth analysis of the distributional qualities of credit spreads across different maturities and ratings classes. Not surprisingly we find consistent evidence against the Normal distribution for both the spread level and changes in the spread. The primary result has important pricing implications for any option embedded in a credit derivative, and in particular options on credit spreads. Risk managers using parametric Value-at-Risk (VaR) techniques assuming a Normal distribution should also be highly concerned with our findings; in particular the far greater than expected number of instances outside the 98% confidence interval. Though Pedrosa and Roll (1998) suggest the negative impact of kurtosis on VaR analysis may be reduced by diversification, high levels of correlation between the different credit spread series shown by Batten, Hogan and Pynnonen (1999) question the likelihood of such a reduction in kurtosis for portfolios of yen denominated spreads, and therefore the viability of traditional VaR methodologies as discussed in the present study.

Examining the individual credit spread series of evidence of a power-law distribution we find that although spreads at for maturities do fall within the range required for a stable Pareto–Levy process, the overall fit of the power-law model is poor and thus provides only weak support for the hypothesis that yen denominated credit spreads are power-law distributed. However the result does not exclude the power-law model altogether as further analysis of the spread changes (which exhibit far higher kurtosis than the equivalent spread levels for all maturities), or of the left- and right-tails individually may yield a better fit than is observed or the spread levels data. The power-law fit to spread changes remains one potential area of further research.

We do find strong support however for the hypothesis that credit spreads conform to a mixture of two Normal distributions model. Compared to findings for a mixture of n Normal distributions, the mixture of two Normal distributions model is shown to have at least the same descriptive power. Our findings with respect to the mixture of two Normal distributions model are, furthermore, consistent with our simulated results for skewness and kurtosis. Taken together with our earlier

discussed findings this support for the mixture of two Normal distributions model is consistent with the implication by Pedrosa and Roll (1998) that VaR models assuming a single Normal distribution will dramatically underestimate the real potential for loss.

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Chapter 10

THE JAPANESE CREDIT RATING ENVIRONMENT: INSIGHTS FROM ISSUERS

Lisa M. Fairchild and Yoon S. Shin

Abstract

The prominence of Japan's public debt market makes it attractive to global credit rating agencies and these agencies often employ aggressive strategies, such as assigning unsolicited ratings, to increase their coverage of Japanese issuers. To obtain insight into the credit rating environment in Japan, we surveyed Japanese issuers about their experiences with ratings agencies and asked their opinion with respect to Japanese-based rating agencies as well as those that are U.S.-based. Responses from our survey participants indicate that issuers' opinions and level of satisfaction are heavily influenced by whether the ratings assigned are solicited or unsolicited. In particular, issuers receiving unsolicited ratings from Moody's expressed the most dissatisfaction. Moreover, these issuers think that the Japanese-based rating agencies more accurately rate Japanese issuers. Interestingly, Japanese issuers receiving solicited ratings expressed no preference for Japanese-based rating agencies over the U.S. rating agencies.

1. INTRODUCTION

Japan's domestic public debt market of approximately \$15.4 trillion makes it second only to the U.S. public debt market in terms of size.¹ Relative to its Asian counterparts, Japan's domestic public debt market is the most rapidly growing.² The significance of the size and the growth of the Japan's public debt market makes it attractive to global credit rating agencies, and these agencies are employing aggressive strategies to increase their coverage of Japanese issuers.

¹ See Eun and Resnick (2003, p. 158).

² See Bank for International Settlements (2000).

According to the *Wall Street Journal*, two U.S.-based credit rating agencies, Moody's and S&P, dominate the world credit services market. These U.S.-based agencies have a combined market share of 79 percent, followed by Fitch with a 14 percent market share and other rating agencies, including A.M. Best and foreign agencies, holding the remaining 6 percent share.³ Although two prominent Japanese rating agencies, Japan Rating and Investment Information (R&I)⁴ and Japan Credit Rating Agency (JCR)⁵, are designated as global credit rating agencies by the Bank for International Settlements (BIS), their global market shares are considerably smaller than those of Moody's and S&P.⁶

Much of Moody's and S&P's aggressive expansion into foreign markets is attributable to their practice of assigning unsolicited ratings. Investors and issuers around the globe are highly critical of Moody's and S&P for this practice. Financial managers in the U.S. are concerned about unsolicited ratings because rating agencies use them to increase revenues from rating fees and to punish issuers for not hiring them to rate their issues.⁷ Japanese issuers are also highly critical of unsolicited ratings as evidenced by a survey of major Japanese firms conducted by the Japan Center for International Finance (JCIF).⁸ According to the survey, 62.5 percent of respondents are dissatisfied with unsolicited ratings assigned by Moody's and S&P. Specifically, the Japanese firms believe that "rating agencies should disclose in greater detail the grounds for their unsolicited ratings and clearly distinguish between which are unsolicited ratings and solicited ratings". Moreover, approximately 30 percent of the JCIF survey respondents believe that rating agencies use unsolicited ratings to increase market share and this practice hurts the reliability of unsolicited ratings.

Japanese firms criticize Moody's more than S&P because Moody's does not differentiate between solicited and unsolicited ratings. Until recently, S&P identified all of its unsolicited ratings by a "pi" (public information) subscript attached to its traditional long-term rating symbols.⁹ Both R&I and JCR clearly differen-

³ See *Wall Street Journal* (2003a, p. C1). The breakdown of the market share is as follows: S&P—41%; Moody's—38%; Fitch—14%; and other agencies—6%.

⁴ R&I is owned by *Nihon Keizai Shimbun*, an economic newspaper.

⁵ JCR is owned by Japanese financial institutions.

⁶ See Bank for International Settlements (2000).

⁷ See "Good To Rate?" *CFO*, September 2003, p. 68.

⁸ The JCIF is a Japanese research organization founded in 1983 with the support of the Ministry of Finance.

⁹ See *Wall Street Journal* (2003b, p. A11). In 1996, S&P began to denote the unsolicited ratings by the "pi" subscript. However, the *Wall Street Journal* reports that S&P will assign new unsolicited ratings to about 100 Japanese firms and not differentiate them from solicited ratings. Furthermore, S&P will sharply expand its coverage in Japan by rating every bond worth more than 10 billion yen (\$90.8 million) for domestic offerings and \$50 million for overseas. The newspaper argues that S&P

tiate unsolicited ratings from solicited ratings; however, the percentage of unsolicited ratings assigned by each of these agencies is much smaller than the portion of solicited ratings.¹⁰

Japanese firms argue that unsolicited ratings are compromised and very conservative because analysts do not have full access to company data. Poon (2003) and Byoun and Shin (2003) provide evidence that unsolicited ratings are biased downward in comparison to solicited ratings. According to Poon (2003), S&P assigned 97 percent of its 323 total unsolicited credit ratings around the world to Asian firms for the period of 1998–2000, compared with only 1 percent of unsolicited ratings assigned to European firms and U.S. firms.¹¹ Byoun and Shin (2003) also use S&P's "pi" ratings (mostly Japanese firms) for their study because of Moody's policy not to distinguish unsolicited ratings from solicited ratings. Their evidence suggests that the U.S. rating agencies aggressively try to expand their market shares in Japan by assigning unsolicited ratings.

The purpose of our study is to provide additional insight into the credit rating environment of Japan. As previously noted, Japan's public debt market is internationally prominent due to its size and rapid growth. Hence, knowledge about the credit rating environment of this market is important. Our study is based on a survey of Japanese firms, and to the best of our knowledge, it is the first international credit rating survey focusing solely on Japanese issuers and rating agencies.

Previous surveys on credit ratings target firms in a specific industry (Ellis, 1998) or country, in particular, the U.S. (Baker and Mansi, 2002).¹² Although Cantwell (1998) surveys 1,800 issuers in the U.S. and 50 foreign countries for their opinion on international rating agencies such as Moody's, S&P, and Fitch, he neither goes into detail about the issuers in foreign countries nor scrutinizes Japanese rating agencies. Moreover, no prior survey investigates the opinion of issuers rated by a specific rating agency. Our survey focuses on Japanese firms rated by Moody's because prior evidence suggests that Japanese firms consider Moody's to be the

dramatically increases its ratings coverage in Japan to fight against its archrivals, Moody's and R&I, and increase market share in Japan, which is the second largest bond market in the world.

¹⁰ Both R&I and JCR assign unsolicited ratings based on public information. R&I denotes its unsolicited ratings as "op" and JCR denotes its unsolicited ratings as "p". As of February 29, 2004, only one of R&I's total 625 credit ratings was an "op" rating, while only 81 of JCR's total 807 credit ratings were "p" ratings. Hence, compared to the number of unsolicited ratings assigned by Moody's and S&P, the Japanese ratings agencies assign far fewer unsolicited ratings.

¹¹ Sixty-seven percent of the total unsolicited ratings assigned by S&P were for Japanese firms.

¹² Ellis (1998) surveys utilities companies and fixed-income investors in the U.S. to investigate their views of rating agencies such as Moody's, S&P, and Fitch. Baker and Mansi (2002) expand Ellis' study and survey U.S. industrial firms and institutional investors to obtain their opinion of the two U.S. rating agencies, Moody's and S&P, as well as Fitch.

most influential rating agency in Japan.¹³ Our survey also highlights unsolicited ratings because unsolicited ratings are a controversial topic in the credit services industry. U.S. issuers are bitterly complaining about them and a Colorado school district sued Moody's for issuing unsolicited ratings.¹⁴ The existing evidence of Ellis (1998) and Baker and Mansi (2002) indicates that most U.S. issuers want rating agencies to identify unsolicited ratings clearly. Similar to U.S. firms, Japanese firms are also reportedly very dissatisfied with unsolicited ratings.¹⁵

The results of our survey indicate that firms with unsolicited ratings have considerably different opinions on rating agencies when compared to those of firms with solicited ratings. For instance, firms with unsolicited ratings are very happy with the performance and rating practices of Japanese agencies while highly dissatisfied with those of U.S. agencies. However, Japanese firms with solicited ratings do not discriminate against U.S. agencies in their evaluation of rating agencies. Additionally, all of the respondents, whether they have unsolicited ratings or not, hired at least one more agency in addition to Moody's. In particular, firms with unsolicited ratings preferred Japanese agencies to U.S. ones when they hire additional agencies, even though firms with solicited ratings do not have any preferences.

In the next section, we describe the data. Section 3 contains a discussion of our results and the conclusion is provided in Section 4.

2. DATA

We sent our survey to 304 private and public Japanese companies rated by Moody's as of August 2003. We limited the focus of our study to Japanese firms rated only by Moody's because Moody's is considered the most influential rating agency in Japan,¹⁶ and Japanese firms have sharply criticized Moody's for assigning unsolicited ratings without differentiating unsolicited ratings from solicited ratings. We chose Japanese firms that have only long-term credit ratings and excluded firms with short-term credit ratings. The list of Japanese firms was identified from www.moodys.com and their addresses were obtained from the *Japan Company Handbook* (2003) or company websites. Our survey period encompassed October through December 2003. The surveys were sent to Japanese financial managers such as Chief Financial Officers (CFO) and treasurers. Also,

¹³ See JCIF (1999).

¹⁴ See The Bond Buyer (1996, p. 1).

¹⁵ See JCIF (1999) for evidence regarding the Japanese viewpoint.

¹⁶ See JCIF (1999).

the survey was translated into Japanese to maximize the response rate and sent by airmail.

Our survey design draws upon the previous survey research of Ellis (1998) and Cantwell (1998). Our survey consists of 30 questions and the questions are divided into five topical areas. The first area covers the opinion of Japanese firms with regard to unsolicited ratings assigned by Moody's. The second evaluates the performance of four major ratings agencies in Japan, i.e. Moody's, S&P, R&I, and JCR. We do not examine other agencies such as Fitch, A.M. Best, and Thomson BankWatch because their influence in Japan is much weaker than the four major players.¹⁷ The third area of our survey deals with questions related to multiple ratings. This issue is included because most firms rated by Moody's may seek ratings from other agencies. The fourth area focuses on important rating criteria selected by Japanese firms while the final area addresses the relationships between issuers and rating agencies.

3. RESULTS

We received 78 valid responses from a total of 304 surveys sent to Japanese firms rated by Moody's. The response rate of 25 percent is similar to that reported by Baker and Mansi (2002) for a survey of U.S. issuers and investors.¹⁸ Moreover, our response rate is higher than the 14 percent rate from non-U.S. issuers reported by Cantwell (1998). Hence, the high response rate to our survey suggests that credit ratings are a topic of considerable interest to Japanese firms.

Our survey results provide interesting insights into five topics regarding credit ratings: (1) unsolicited ratings; (2) Japanese firms' view of the performance of ratings agencies; (3) multiple ratings; (4) important rating criteria; and (5) relationships between issuers and the ratings agencies. In the following sections, we present a discussion of our survey results according to these topics.

3.1. Unsolicited Ratings

Table 10.1 provides information about the distribution of the ratings for the firms surveyed. Twenty-nine of the firms responding to the survey had solicited ratings from Moody's while 49 had unsolicited ratings. From Table 10.1 it can be seen that the distribution of ratings for firms with solicited ratings is skewed toward

¹⁷ See JCIF (1999).

¹⁸ Our response rate is especially impressive given that all of our respondents are overseas and this makes follow-up difficult.

Table 10.1

Distribution of Moody's Ratings across Firms. This table provides the distribution of ratings for all firms in our survey as well as those responding to the survey that had either solicited or unsolicited ratings assigned by Moody's

Rating Category	Firms with Solicited Ratings from Moody's		Firms with Unsolicited Ratings from Moody's		All Firms Surveyed	
	Number of Ratings	Percent of Firms with Solicited Ratings	Number of Ratings	Percent of Firms with Unsolicited Ratings	Number of Ratings	Percent of All Firms Surveyed
Aaa	0	0.00%	0	0.00%	0	0.00%
Aa	10	34.48%	4	8.16%	35	11.51%
A	9	31.03%	5	10.20%	83	27.30%
Baa	7	24.14%	22	44.90%	118	38.82%
Ba	1	3.45%	11	22.45%	44	14.47%
B	2	6.90%	6	12.24%	21	6.91%
Caa and below	0	0.00%	1	2.04%	3	0.99%
Total	29	100.00%	49	100.00%	304	100.00%

higher quality ratings when compared with those of firms with unsolicited ratings from Moody's.

Table 10.2 contains the results of the series of six survey questions that were directed toward the firms with unsolicited ratings. Similar to the sentiment suggested by JCIF (1999), the majority of Japanese firms participating in our survey are dissatisfied with the unsolicited ratings assigned by Moody's. Specifically, Panel A of Table 10.2 reports that 61.22 percent of the firms are dissatisfied with unsolicited ratings from Moody's and is very similar to the 62 percent of respondents to the JCIF (1999) survey expressing dissatisfaction with Moody's unsolicited ratings. Moreover, consistent with evidence regarding U.S. issuers reported by Ellis (1998) and Baker and Mansi (2002), the results in Panel B overwhelmingly suggest that issuers want unsolicited ratings to be distinguished from solicited ratings. Panel C reinforces the dissatisfaction with Moody's because 85.71 percent of the firms with unsolicited ratings from Moody's have decided not to seek solicited ratings from Moody's. Panels D, E, and F of Table 10.2 provide additional insights into the opinions of the Japanese firms with unsolicited ratings. In Panel D, 75.51 percent of the firms "Somewhat Agree" or "Agree" that Moody's should provide more detail about the basis for providing unsolicited ratings. In Panel E, the majority of these firms "Somewhat Agree" or "Agree" that unsolicited ratings are used to pressure firms into obtaining solicited ratings and unsolicited ratings create reliability problems. However, despite the dissatisfaction with unsolicited ratings and the alleged reliability problems of these ratings, the Japanese firms with unsolicited ratings from Moody's do not advocate regulatory action against Moody's to curtail this practice. The responses in Panel F indicate that 36.74 percent of the firms with unsolicited ratings think regulations should be imposed, while 40.81 percent of the firms "Disagree" or "Somewhat Disagree" about the need for regulatory action.

Table 10.3 asks firms with unsolicited ratings from Moody's about the type of information they are willing to provide Moody's. We pose this question because S&P assigns unsolicited ratings based solely on publicly available information while Moody's focuses on non-public information. Specifically, Moody's contacts firms and requests non-public information for use in determining their unsolicited ratings. As shown in Table 10.3, over 50 percent of our responding firms indicate that they disclose at least some non-public information to Moody's. This result suggests that firms try to accommodate Moody's requests for non-public information. Moreover, firms most likely cooperate with Moody's requests for non-public information in the hope of receiving a better unsolicited rating than would otherwise be given. Because Moody's and S&P rely on different types of data (non-public vs. publicly available) to assign unsolicited ratings, and our respondents indicate a clear dissatisfaction with Moody's unsolicited ratings, a

Table 10.2

The Opinion of Japanese Firms with Respect to Moody's Unsolicited Ratings. This table presents the opinion of Japanese firms with regard to unsolicited credit ratings assigned by Moody's. Only firms with unsolicited ratings ($N = 49$) answered questions. N is the total number of responding firms. Each panel reports a survey question and its responses

	PANEL A: Are you satisfied with the unsolicited ratings assigned by Moody's?		PANEL B: Do you feel unsolicited ratings should be clearly identified in ratings publications (should Moody's clearly distinguish between which ratings are solicited and unsolicited)?		PANEL C: Have you ever solicited (requested) ratings from Moody's since your initial long-term ratings were unsolicited?	
Possible Responses	Number of Responses ($N = 49$)	Percentage	Number of Responses ($N = 49$)	Percentage	Number of Responses ($N = 49$)	Percentage
Yes	8	16.33%	41	83.68%	7	14.29%
No	30	61.22%	6	12.24%	42	85.71%
Don't Know	11	22.45%	2	4.08%	—	—
	PANEL D: Moody's should disclose in greater detail the grounds for their unsolicited ratings.		PANEL E: Unsolicited ratings are used by Moody's in their marketing strategy to solicit ratings, and this creates problems regarding the reliability of ratings.		PANEL F: Regulations should be imposed on the activities of Moody's because of unsolicited ratings.	
	Number of Responses ($N = 49$)	Percentage	Number of Responses ($N = 49$)	Percentage	Number of Responses ($N = 49$)	Percentage
Agree	25	51.02%	9	18.37%	8	16.33%
Somewhat Agree	12	24.49%	19	38.78%	10	20.41%
Neither Agree nor Disagree	9	18.37%	14	28.57%	11	22.45%
Somewhat Disagree	3	6.12%	6	12.24%	17	34.69%
Disagree	0	0.00%	1	2.04%	3	6.12%

Table 10.3

Information Provided to Moody's for Unsolicited Ratings. This table reports information provided to Moody's for unsolicited ratings. Only firms with unsolicited ratings answered the question. The total number of responding firms is 48

What level of information including financial disclosure do you routinely provide to Moody's for unsolicited ratings?		
Possible Response	Number of Responses (<i>N</i> = 48)	Percentage
Publicly available information only	20	41.67%
Selected non-public information	17	35.42%
Substantial non-public information	11	22.91%

Table 10.4

Satisfaction with Unsolicited Ratings from S&P. This table presents responses from Japanese firms, which have solicited or unsolicited ratings by Moody's, to the question of satisfaction with regard to unsolicited ratings from S&P. All the responded firms have "pi" ratings assigned by S&P. "Pi" ratings are unsolicited ratings based on only public information

If you have unsolicited ratings ("pi" ratings) from S&P, are you satisfied with the unsolicited ratings assigned by S&P?

Possible Response	Firms with Solicited Ratings		Firms with Unsolicited Ratings	
	Number of Responses (<i>N</i> = 9)	Percentage	Number of Responses (<i>N</i> = 27)	Percentage
Yes	3	33.33%	3	11.11%
No	3	33.33%	20	74.07%
Don't Know	3	33.33%	4	14.82%

follow-up question was asked with respect to satisfaction with unsolicited ratings from S&P. This follow-up question is intended to determine if there is similar dissatisfaction with S&P or if the dissatisfaction is unique to Moody's unsolicited ratings.

Table 10.4 contains the responses with regard to the satisfaction of unsolicited ratings received from S&P. Similar to the responses for Moody's, there is a high level of dissatisfaction with S&P's unsolicited ratings. This is an interesting result given the overwhelming response in Panel B of Table 10.2 indicating that issuers believe unsolicited ratings should be distinguished from solicited ratings. Hence, although S&P distinguishes its unsolicited ratings with a "pi" subscript, firms are still unhappy with unsolicited ratings. However, the dissatisfaction with S&P's

unsolicited ratings documented by our survey may be due to the fact that S&P's unsolicited ratings are systematically lower than ratings assigned by Japanese-based agencies. Poon (2003), Shin and Moore (2003), and Byoun and Shin (2003) provide empirical evidence that unsolicited ratings from S&P are systematically lower than ratings from Japanese-based agencies. Moreover, Shin and Moore find that Moody's ratings are systematically lower than those of Japanese-based agencies. Hence, the empirical evidence offers an explanation for the unsolicited ratings dissatisfaction reported by our survey firms.

3.2. *Evaluation of the Performance of Ratings Agencies*

Panels A and B of Table 10.5 contain the results of survey questions asking opinions with respect to the most influential rating agency in Japan and which agency provides the best service. The responses in Panel A were obtained by asking the Japanese firms to rank the top four rating agencies from 1 to 4, with 1 being "most influential" and 4 being "least influential". According to Panel A, firms with solicited ratings consider Moody's to be the most influential agency while the Japanese-based agency, R&I, was a close second. However, the firms with unsolicited ratings overwhelmingly view R&I as the most influential rating agency and Moody's is a distant second. The results for the best service reported in Panel B show a similar pattern to those in Panel A. Again the firms with solicited ratings rank Moody's as providing the best service, while the firms with unsolicited ratings consider R&I to perform the best service.

Table 10.6 contains the results of a follow-up question asking the Japanese firms surveyed to indicate the reason for choosing the agency they indicated provided the best service in Panel B of Table 10.5. The top responses indicate a similar reason for the choices for both subsamples of firms—"understand issuers". "Accurate research" is the second most cited reason for both subsamples. Hence, although the firms with solicited ratings disagree with the firms having unsolicited ratings as to *which* agency provides the best service, the two subsamples do agree on the *reason* for their choice of agency providing the best service.

The Japanese firms surveyed were asked "Does each rating agency give issuers sufficient opportunity to explain before assigning or changing ratings?" To respond to this question, the surveyed firms were asked to rate each agency. The results of this question are presented in Table 10.7. The responses in Table 10.7 are stratified according to firms with solicited ratings and firms with unsolicited ratings. The mean responses from both subsamples indicate that R&I does the best job of providing firms the opportunity to explain before assigning or changing ratings. The firms with unsolicited ratings view the other Japanese-based agency,

Table 10.5

Evaluation of the Four Major Ratings Agencies by Japanese Issuers. This table shows the evaluation of the four major credit rating agencies in Japan. Moody's and S&P are credit rating agencies in the U.S. and R&I and JCR are Japanese credit rating agencies. The total number of responses of Panel A is 28 for firms with solicited ratings and 47 with unsolicited ratings and that of Panel B is 27 for firms with solicited ratings and 43 with unsolicited ratings

	PANEL A: What is the most influential rating agency in Japan?		PANEL B: Which rating agency performs the best service in Japan?	
	Number of Responses from Firms with Solicited Ratings (<i>N</i> = 28)	Number of Responses from Firms with Unsolicited Ratings (<i>N</i> = 47)	Number of Responses from Firms with Solicited Ratings (<i>N</i> = 27)	Number of Responses from Firms with Unsolicited Ratings (<i>N</i> = 43)
Moody's	16	11	13	6
S&P	6	7	3	8
R&I	15	32	6	24
JCR	1	2	1	6

Table 10.6

Reason for Indicating the Rating Agency in Panel B of Table 10.5 is the Best Agency. This table reports the reasons of why Japanese firms consider the agency in Panel B of Table 10.5 the best credit rating agency

	Why do you consider the agency you rated in Panel B of Table 10.5 the best?			
	Firms with Solicited Ratings (<i>N</i> = 23)		Firms with Unsolicited Ratings (<i>N</i> = 42)	
Possible Response	Number of Responses	Percentage	Number of Responses	Percentage
Accurate Research	8	34.78%	14	33.33%
Objectivity	6	26.09%	12	28.57%
Timeliness	0	0.00%	1	2.38%
Understand Issuers	12	52.17%	15	35.71%
Consistency	7	30.43%	10	23.81%

JCR, as a close second, while the firms with solicited ratings rank Moody's as second to R&I.

Issuers were also asked to rank each rating agency with respect to the accuracy of their current ratings. The ranking of responses in Table 10.8 are consistent

Table 10.7

Survey Question: Does Each Rating Agency Give Issuers Sufficient Opportunity to Explain before Assigning or Changing Ratings? This table provides answers to the questions of “does each rating agency give issuer sufficient opportunity to explain before assigning or changing ratings?” Respondents ranked each rating agency on a five-point scale from 1 (agree) to 5 (disagree). Therefore, when the mean rankings are lower, rating agencies give an issuer more sufficient opportunity to explain before assigning or changing ratings

Rating Agency Considered	Firms with Solicited Ratings (<i>N</i> = 27)					Mean Response
	1 Agree	2 Somewhat Agree	3 Neither Agree nor Disagree	4 Somewhat Disagree	5 Disagree	
Moody's	9	13	2	2	1	2.00
S&P	6	5	7	3	1	2.45
R&I	8	14	2	0	0	1.75
JCR	5	6	4	2	0	2.18

Rating Agency Considered	Firms with Unsolicited Ratings (<i>N</i> = 47)					Mean Response
	1 Agree	2 Somewhat Agree	3 Neither Agree nor Disagree	4 Somewhat Disagree	5 Disagree	
Moody's	7	6	13	13	7	3.15
S&P	5	5	9	7	13	3.46
R&I	26	9	6	4	0	1.73
JCR	18	6	9	0	1	1.82

across both subsamples of firms. That is, the firms with solicited ratings and the firms with unsolicited ratings both view JCR as providing the most accurate ratings. Moreover, across both subsamples, R&I was considered second most accurate, followed by Moody's and S&P.

As part of the Japanese firms' evaluation of the performance of rating agencies, we asked the survey participants if the rating agencies understand their concerns regarding their ratings. The results from this question are presented in Table 10.9. The firms with solicited ratings suggest that Moody's, S&P, and R&I understand issuers' concerns. JCR is the only agency without a majority of “Yes” responses to the question. However, when the results for the firms with unsolicited ratings are considered, only the Japanese-based agencies, R&I and JCR, are thought to un-

Table 10.8

Issuers Opinion Regarding the Accuracy of Their Current Ratings. This table presents issuers opinion regarding the accuracy of their current ratings. Respondents ranked each rating agency on a five-point scale from 1 (much too high) to 5 (much too low). Therefore, when the mean rankings are higher, firms believe assigned ratings are lower than actual credit worthiness

Rating Agency Considered	Firms with Solicited Ratings (<i>N</i> = 27)					Mean Response
	1	2	3	4	5	
	Much Too High	Too High	About Right or Adequate	Too Low	Much Too Low	
Moody's	0	0	12	12	4	3.71
S&P	0	0	9	10	4	3.78
R&I	0	1	15	7	1	3.33
JCR	2	1	10	4	0	2.94

Rating Agency Considered	Firms with Unsolicited Ratings (<i>N</i> = 47)					Mean Response
	1	2	3	4	5	
	Much Too High	Too High	About Right or Adequate	Too Low	Much Too Low	
Moody's	0	0	10	20	16	4.13
S&P	0	0	8	15	13	4.14
R&I	0	0	20	21	0	3.51
JCR	0	3	21	8	0	3.16

derstand issuers' concerns. For Moody's and S&P, the "Yes" responses represent the minority opinion of firms with unsolicited ratings.

When the surveyed firms are asked about the quality of the rating agencies' published research or analysis on their firms, there is a consistent perception across the two subsamples that R&I provides the best quality published research and analysis. According to Table 10.10, the mean response for R&I from firms with solicited ratings is 2.64, while the mean response for R&I from firms with unsolicited ratings is 2.79. Moody's ranks second among the firms with solicited ratings followed by S&P and then JCR. The firms with solicited ratings consider the quality of the published research or analysis from Moody's, S&P, and R&I to rate between "Satisfactory" and "Good". JCR is the only agency that these firms consider to have published research or analysis quality in the "Satisfactory" to "Unsatisfactory" range. In contrast, the firms with unsolicited ratings consider JCR to have the second best quality published research or analysis. With a mean

Table 10.9

Survey Question: Do Rating Agencies Understand Issuer's Concerns Regarding Ratings? This table contains responses to the question of "do rating agencies understand your concerns regarding your ratings?" Moody's and S&P are credit rating agencies in the U.S. and R&I and JCR are Japanese credit rating agencies

	Firms with Solicited Ratings (<i>N</i> = 28)		
	Yes	No	Don't Know
Moody's	22	0	6
S&P	15	1	10
R&I	15	2	9
JCR	8	0	12

	Firms with Unsolicited Ratings (<i>N</i> = 48)		
	Yes	No	Don't Know
Moody's	14	9	25
S&P	11	7	24
R&I	31	4	11
JCR	21	3	12

response of 2.84, these firms consider JCR to have "Satisfactory" to "Good" quality published research and analysis. Moreover, the firms with the unsolicited ratings consider both Moody's and S&P to have published research or analysis that is in the "Satisfactory" to "Unsatisfactory" range. This response further highlights the firms with unsolicited ratings dissatisfaction with Moody's and S&P.

Similar to the results of the previous questions evaluating the performance of the rating agencies, the opinion of the firms with solicited ratings differ from those of the firms with unsolicited ratings when the timely maintenance of ratings is considered. The results surrounding the timely maintenance of ratings are presented in Table 10.11. As evidenced by the mean responses of 1.90 and 2.04, S&P and Moody's, respectively, are considered by the firms with solicited ratings as doing the best job with respect to timely maintenance of ratings. In contrast, the firms with unsolicited ratings report that R&I and JCR do the best job of maintaining ratings. The mean responses for R&I and JCR were 1.82 and 1.91, respectively.

The overall preference of R&I and JCR by firms with unsolicited ratings from Moody's is not surprising when prior empirical evidence is considered. Specifically, Shin and Moore (2003) find that R&I and JCR systematically assign higher

Table 10.10

Survey Question: How Would You Evaluate the Quality of Rating Agencies' Published Research or Analysis on Your Company? This table reports the evaluation of the quality of rating agencies' published research or analysis. Respondents ranked each rating agency on a five-point scale from 1 (excellent) to 5 (poor). Therefore, when the mean rankings are lower, the quality of rating agencies' published research or analysis on an issuer is better

Rating Agency Considered	Firms with Solicited Ratings (N = 27)					Mean Response
	1 Excellent	2 Good	3 Satisfactory	4 Unsatisfactory	5 Poor	
Moody's	4	7	10	6	0	2.67
S&P	4	4	5	6	2	2.90
R&I	1	9	10	1	1	2.64
JCR	0	2	7	5	1	3.33

Rating Agency Considered	Firms with Unsolicited Ratings (N = 47)					Mean Response
	1 Excellent	2 Good	3 Satisfactory	4 Unsatisfactory	5 Poor	
Moody's	2	5	12	21	3	3.42
S&P	2	1	14	18	2	3.46
R&I	1	17	14	10	0	2.79
JCR	2	10	12	7	1	2.84

ratings to Japanese firms relative to those assigned by Moody's and S&P. Hence, our survey results corroborate the existing empirical evidence.¹⁹

Tables 10.12 and 10.13 provide results for questions dealing with the rating agency analysts. In Table 10.12, Moody's and S&P's analysts earn the highest marks from firms with solicited ratings for their level of preparation and knowledge of the company. However, firms with unsolicited ratings regard the analysts of R&I and JCR most highly with respect to preparation and knowledge. A possible reason for the differences in the responses among the two subsamples could be high turnover of analysts at the rating agencies. However, the results in Table 10.13 do not indicate that there is a high degree of turnover among analysts at the rating agencies. The majority of firms in the two subsamples indicate that they deal with the same primary analyst at each agency.

¹⁹ Within the popular press, there is additional evidence of R&I's strong influence in Japan. The *Wall Street Journal* reports that Morgan Stanley selected R&I as the best rating agency in Japan in 2000 and 2001, followed by Moody's, then and S&P. See *Wall Street Journal* (2002, p. C1).

Table 10.11

Survey Question: Are Ratings Maintained on a Timely Basis? This table presents the timeliness of ratings. Respondents ranked each rating agency on a four-point scale from 1 (virtually always) to 4 (usually lag). Therefore, when the mean rankings are lower, rating agencies maintain ratings on a timelier basis.

Rating Agency Considered	Firms with Solicited Ratings (<i>N</i> = 26)				Mean Response
	1 Virtually Always	2 Most of the Time	3 Often Lag	4 Usually Lag	
Moody's	7	14	2	3	2.04
S&P	6	12	0	2	1.90
R&I	5	10	5	3	2.26
JCR	4	6	3	4	2.41

Rating Agency Considered	Firms with Unsolicited Ratings (<i>N</i> = 46)				Mean Response
	1 Virtually Always	2 Most of the Time	3 Often Lag	4 Usually Lag	
Moody's	7	24	5	6	2.24
S&P	6	19	6	6	2.32
R&I	15	23	5	1	1.82
JCR	9	7	6	0	1.91

3.3. Multiple Ratings

Similar to many firms in the U.S., Japanese firms often hire more than one rating agency to rate their debt. Hiring additional rating agencies reduces the costs of information asymmetry between issuers and investors because the additional ratings provide information beyond that contained in the initial single rating. The reduction of information asymmetry costs translates into lower borrowing costs for issuers.²⁰ Table 10.14 reports the agencies that Japanese firms hire in addition to Moody's. For both the firms with solicited ratings and the firms with unsolicited ratings, R&I ranks as the number one agency hired in addition to Moody's. However, differences appear when the second and third most hired agencies are considered. The firms with solicited ratings rank S&P second and JCR third. However, just the opposite is true for firms with unsolicited ratings. Table 10.15 reinforces

²⁰ See Hsueh and Kidwell (1998), Cantor and Packer (1995), Jewell and Livingston (1999, 2000) and Thompson and Vaz (1990) for the benefits of additional ratings.

Table 10.12

How Would you Evaluate the Primary Analyst of Rating Agencies in Terms of His/Her Preparation for the Rating Meeting and Knowledge of Your Company? This table reports the evaluation of the primary analyst of rating agencies. Respondents ranked the primary analyst of each rating agency on a five-point scale from 1 (excellent) to 5 (poor). Therefore, when the mean rankings are lower, the primary analyst of rating agencies is better in terms of his/her preparation for the rating meeting and knowledge of the company that he/she rates

Rating Agency Considered	Firms with Solicited Ratings (<i>N</i> = 27)					Mean Response
	1 Excellent	2 Good	3 Satisfactory	4 Unsatisfactory	5 Poor	
Moody's	6	12	6	3	0	2.22
S&P	3	7	7	3	1	2.62
R&I	0	7	11	3	1	2.91
JCR	0	4	6	4	1	3.13

Rating Agency Considered	Firms with Unsolicited Ratings (<i>N</i> = 46)					Mean Response
	1 Excellent	2 Good	3 Satisfactory	4 Unsatisfactory	5 Poor	
Moody's	6	8	9	12	1	2.83
S&P	1	6	8	11	2	3.25
R&I	4	17	14	6	1	2.57
JCR	4	12	9	3	2	2.57

the results from Table 10.14. In Table 10.15, the firms with solicited ratings report that when two additional agencies are hired, most often those two agencies are S&P and R&I. If three additional agencies are hired, they are most often S&P, R&I, and JCR. In contrast, the firms with unsolicited ratings are more likely to hire two additional agencies or even only one. In either case, R&I is most often hired in addition to Moody's. If a second agency is hired, it is usually JCR. Hence, the firms with unsolicited ratings consistently prefer the Japanese-based agencies when additional agencies are hired.

The surveyed firms were asked the reasons for hiring agencies in addition to Moody's. The reasons cited are contained in Table 10.16. Overwhelmingly, the firms with solicited ratings cited a recommendation from an investor or banker as why additional agencies were hired. However, the firms with unsolicited ratings frequently cited multiple reasons for hiring additional rating agencies. The number one reason provided by these firms is the occurrence of a split rating.

Table 10.13

Turnover of Analysts at Rating Agencies. This table contains information regarding the turnover of analysts at rating agencies. Moody's and S&P are credit rating agencies in the U.S. and R&I and JCR are Japanese credit rating agencies

Rating Agency Considered	Firms with Solicited Ratings (<i>N</i> = 28)		Firms with Unsolicited Ratings (<i>N</i> = 45)	
	Deal with the Same Primary Analyst	High Level of Analyst Turnover	Deal with the Same Primary Analyst	High Level of Analyst Turnover
Moody's	25	3	29	6
S&P	17	5	19	6
R&I	18	5	31	10
JCR	12	3	24	7

Table 10.14

Rating Agencies Hired in Addition to Moody's. This table shows the opinion of Japanese firms with regard to split ratings. The question is "what are the names of rating agencies that you hire in addition to Moody's?" All responding firms have either solicited ratings or unsolicited ratings by Moody's

	Firms with Solicited Ratings (<i>N</i> = 26) ⁴	Firms with Unsolicited Ratings (<i>N</i> = 47) ⁴
S&P	19	17
R&I	23	42
JCR	12	27
Fitch ¹	4	2
A.M. Best ²	1	1
DBRS ³	2	0

¹Fitch is a French credit rating agency.

²A.M. Best is an American credit rating agency specializing in the insurance industry.

³DBRS is Dominion Bond Rating Service in Canada.

⁴The numbers in each column do not add up to the number of firms responding (*N*) because many firms use more than one additional agency.

The second reason was a tie between obtaining an investment grade rating and a recommendation from an investor or a banker. These firms also indicated that they hired additional rating agencies because Moody's assigned them unsolicited ratings.

Table 10.15

Number of Additional Rating Agencies Hired by Japanese Issuers Rated by Moody's. This table presents the number and the names of additional rating agencies hired by Japanese issuers rated by Moody's. Moody's and S&P are credit rating agencies in the U.S. and R&I and JCR are Japanese credit rating agencies

Number of Additional Agencies and Name(s) of Additional Agencies Hired	Firms with Solicited Ratings (<i>N</i> = 26)	Firms with Unsolicited Ratings (<i>N</i> = 47)
1 Additional Agency—(S&P)	2	1
1 Additional Agency—(R&I)	4	13
1 Additional Agency—(JCR)	1	3
2 Additional Agencies—(S&P, R&I)	6	6
2 Additional Agencies—(R&I, JCR)	2	14
2 Additional Agencies—(S&P, JCR)	0	1
3 Additional Agencies—(S&P, R&I, JCR)	6	6
4 or more Additional Agencies	5	3

Table 10.16

Reasons Japanese Issuers Hire Rating Agencies in Addition to Moody's. This table answers to the question of "Why did you hire the additional agencies in addition to Moody's?" *N* is the number of firms that answered the question

Possible Response	Firms with Solicited Ratings (<i>N</i> = 26)	Firms with Unsolicited Ratings (<i>N</i> = 46)
Dissatisfaction with current rating	2	7
To obtain an investment-grade rating	3	10
Investor or banker recommendation	19	10
Split rating	5	14
Rating change	2	0
Investors value the ratings of Japanese agencies	3	7
Moody's ratings are unsolicited	0	9

3.4. Important Rating Criteria

Survey participants were asked their opinion as to the single most important criteria for judging an issuer's credit-worthiness. The results of this question are reported in Table 10.17. The responses from the firms with solicited ratings were very similar to those of the firms with unsolicited ratings. Both subsamples highlighted "Capital Structure" and "Profitability" as the top two criteria. It is also

Table 10.17

Issuers' Opinion of the Single Most Important Factor in Evaluating an Issuer's Credit-Worthiness. This table presents credit rating criteria that Japanese firms consider important when rating agencies evaluate the creditworthiness of issuers. All responding firms have either solicited ratings or unsolicited ratings by Moody's. N is the number of firms that answered the question. The question is "What is the single most important factor in evaluating an issuer's creditworthiness?"

Possible Response	Firms with Solicited Ratings ($N = 28$)	Firms with Unsolicited Ratings ($N = 47$)
Competitive environment	2	2
Regulatory environment	2	1
Management quality	7	7
Operating efficiency	1	0
Capital structure (debt ratio)	10	11
Profitability	9	22
Cash flow protection	5	6
Interest coverage ratio	1	1
Growth potential	3	3
Corporate governance	2	0

interesting to note that for both subsamples, corporate governance was ranked near the bottom of the list of criteria. This result supports the empirical evidence of Shin and Moore (2003) that indicates that corporate governance does not influence Japanese bond ratings.

3.5. Relationships between Issuers and Rating Agencies

Tables 10.18 and 10.19 provide insight into the relationships between issuers and the rating agencies. The results from all four tables indicate that the relationship between firms with solicited ratings and rating agencies are very similar to those for firms with unsolicited ratings. For example, in Table 10.18, both categories for firms report more frequent meetings with R&I than the other three agencies. In general, however, the firms with unsolicited ratings appear to meet less frequently with rating agencies than firms with solicited ratings. The lower frequency of meetings is suggested by the lower mean responses relative to those for the firms with solicited ratings.

Table 10.19 provides evidence regarding the initiation of annual meetings between issuers and rating agencies. Firms with solicited ratings appear to have a relatively "balanced" relationship with their rating agencies. In many instances, it appears that the issuers initiate the annual meeting. However, when the firms with

Table 10.18

Frequency of Issuers' Meeting with Rating Agencies. This table shows the frequency of issuers' meeting with rating agencies. All responding firms have either solicited ratings or unsolicited ratings by Moody's. *N* is the number of firms that answered the question. The question is "How frequently do you normally meet with rating agencies?"

	Firms with Solicited Ratings ¹ (<i>N</i> = 27)				Mean Response
	1 Less than one time per year	2 Once per year	3 Twice per year	4 Three or more times per year	
Moody's	2	12	5	7	2.65
S&P	2	10	3	7	2.68
R&I	1	10	4	8	2.83
JCR	3	6	3	4	2.50

	Firms with Unsolicited Ratings ¹ (<i>N</i> = 44)				Mean Response
	1 Less than one time per year	2 Once per year	3 Twice per year	4 Three or more times per year	
Moody's	22	14	2	0	1.47
S&P	20	9	3	1	1.55
R&I	6	29	4	2	2.05
JCR	10	21	1	1	1.78

¹ Respondents ranked each rating agency on a four-point scale as follows: 1 = less than once a year; 2 = once a year; 3 = twice a year; 4 = three or more times per year. Therefore, when the response is low, firms meet rating agencies less frequently.

unsolicited ratings are considered, more often than not, the rating agency initiates the annual meeting.²¹

²¹ Our survey results suggest that the length of time for the annual meeting is relatively similar for firms with solicited ratings and for firms with unsolicited ratings. Most annual meetings reportedly last more than two hours, and the CFO is usually the highest ranking officer attending the annual review meeting for firms that have solicited ratings as well as for firms with unsolicited ratings. Details of these results are available from the authors upon request.

Table 10.19

Survey Question: Who Initiates the Annual Meetings between the Issuers and Rating Agencies? This table shows the relationship between the issuers and rating agencies. All responding firms have either solicited ratings or unsolicited ratings by Moody's. N is the number of firms that answered the question. The question is "do you initiate the annual ratings meetings or does the rating agency initiate them?"

	Firms with Solicited Ratings ($N = 25$)		Firms with Unsolicited Ratings ($N = 46$)	
	Issuer Initiated	Rating Agency Initiated	Issuer Initiated	Rating Agency Initiated
Moody's	11	13	6	28
S&P	12	8	3	21
R&I	11	9	10	30
JCR	4	9	6	21

4. CONCLUSION

This paper discusses the results of a comprehensive survey of Japanese firms' opinions on credit ratings and credit rating agencies. The survey questions encompass five topical areas related to credit ratings: (1) unsolicited ratings; (2) Japanese firms' view of the performance of rating agencies; (3) multiple ratings; (4) important rating criteria; and (5) relationships between issuers and the rating agencies.

The results of our survey suggest that issuers have considerably different opinions based on whether or not they have solicited or unsolicited ratings. Our results indicate that firms with unsolicited ratings are satisfied with the performance and rating practices of Japanese-based agencies while highly dissatisfied with those of U.S.-based agencies. In contrast, Japanese firms with solicited ratings do not discriminate against U.S.-based agencies in their evaluation of rating agencies. Additionally, all of the survey respondents hired at least one agency in addition to Moody's. When hiring additional rating agencies, firms with unsolicited ratings prefer Japanese-based agencies over U.S.-based agencies. However, firms with solicited ratings do not express such a preference.

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Chapter 11

CREDIT RATINGS IN THE JAPANESE BOND MARKET

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Abstract

Recently, credit ratings have been enhancing the influence on issuers as well as the national economy. This chapter explains the historical development and several current features of the Japanese bond market, and discusses why credit ratings gained a significant role in the 1990s. We also present empirical research on credit ratings in the Japanese bond market, and discuss how foreign raters tend to assign lower credit ratings than Japanese ones, but that the relative ratings among raters end up being similar. Finally, we clarify the issues that remain to be solved before credit rating companies can be considered truly reliable.

1. INTRODUCTION

Many observers (e.g., Allen and Gale, 2000) regard Japan and Germany as bank-centered economies and the United States and United Kingdom as market-centered economies. For example, Figure 11.1 shows that German firms obtained only 1% of funds by issuing bonds and Japanese firms obtained 8% of funds by issuing bonds during the 1997–2001 period. Thus, the bond markets in Japan and Germany have historically played only a marginal role in corporate financing.

However, we would like to point out that the Japanese securities market has become important in recent years. Figure 11.2 focuses on recent developments. During the late 1980s, which was called “the bubble period”, “securities excluding stocks” increased because of the increase in the issuance of equity-related bonds, such as convertible bonds and warrant bonds. Furthermore, the financial deregulation and reforms in the late 1990s (e.g., the Japanese Financial Big Bang)

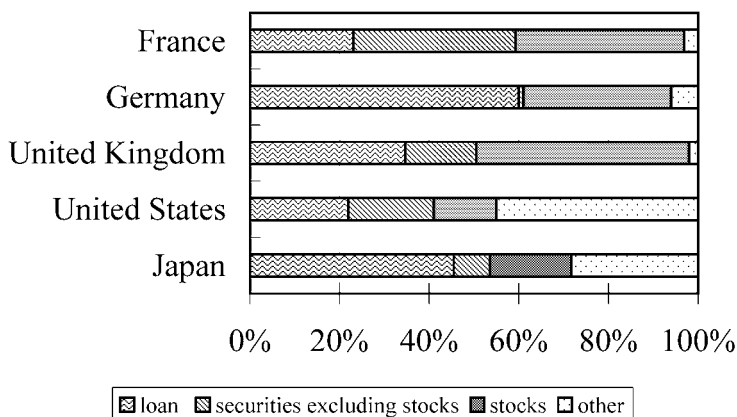


Fig. 11.1. Recent Rising Funds of Non-Financial Corporations: International Comparison. *Note.* The data period is from 1997 to 2001. Source: Figures are directly provided by the Bank of Japan. The Bank of Japan calculated these figures based on the Flow of Funds statistics of each country. (Bank of Japan, “International comparison of the Flow of Funds statistics”, December 2003.)

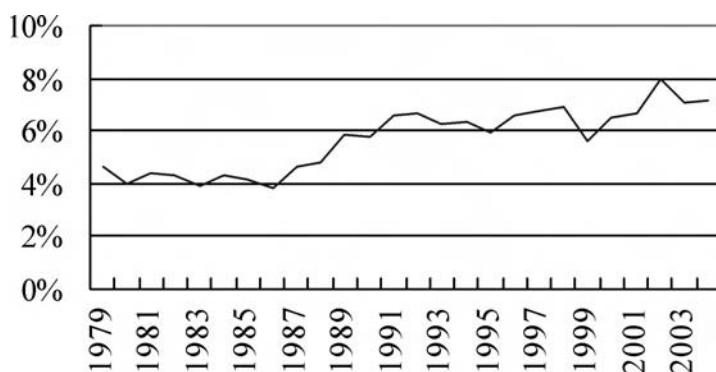


Fig. 11.2. Shares of Securities Excluding Stocks in Total Liability of Japanese Non-Financial Corporations. *Note.* Bank of Japan, Flow of Funds (93SNA base), covering the period from 1979 to today

have fostered the securities markets, and the share of securities in private firms liabilities has reached around 8%.¹ Thus, although the absolute level is not yet high

¹ Current Flow of Funds statistics (93SNA base) are available since 1979. According to the old Flow of Funds statistics (68SNA base), total liabilities of Japanese non-financial corporations at the end of the first quarter of 1965 were 48.3 trillion yen, while “securities excluding stocks” and loans of Japanese non-financial corporations were 1.7 trillion yen and 24.7 trillion yen, respectively. Therefore,

if compared with the U.S. figure, it is clear that the bonds market has steadily increased its importance in Japanese corporate financing.

With the development of the bond market, credit ratings have been enhancing the market's influence on the economy since the 1990s. As explained below, for a long time after the Second World War, only firms that were unlikely to fail (such as utility companies) were allowed to issue bonds. Furthermore, even when issuers went to bankruptcy, all bondholders were protected because bond issuer's main bank, which served as a commission bank, usually purchased all bonds at face values. Therefore, bond investors did not have to worry about the probability of issuers' defaults.

This situation changed in the 1990s. After the bond market was deregulated, firms that had not been allowed to issue bonds before could now issue them, and actually did issue. Unfortunately, several bond issuers went into default. In addition, due to weakening solvency, banks could no longer absorb bondholders' losses. Regarding private placement domestic bonds, Muramoto Construction, which failed in 1993, defaulted its bonds for the first time in Japan. Following Muramoto's default, there have been a number of failures which have caused financial losses to bondholders (see Table 11.1). Furthermore, as shown in the table, the collection rates were on average lower in Japan than in the United States, where the rates are alleged to be about 40%. Because of these low collection rates, investors evaluated the risk of bonds carefully. Reflecting the needs of investors, credit ratings began to play an important role in the Japanese bond market.

This chapter aims to explain the current role and issues of credit ratings in the Japanese bond market. The chapter is organized as follows. In Section 2, we explain the historical development of the Japanese bond market and several features of the market up until the 1980s, during which credit ratings were given only a minor role. In Section 3, we discuss why credit ratings played a significant role in the 1990s. In addition, we provide two episodes that show the impact of credit ratings on the nation and private firms. Although S&P and Moody's are important raters in Japan, there are three Japanese raters which are very different from U.S. raters in terms of rating policy. Therefore, to enable international readers to understand the difference between Japanese and U.S. raters, we provide an explanation of the important features of Japanese credit raters in Section 4. In Section 5, we present findings from empirical research we conducted on credit ratings in the Japanese bond market. We found that foreign raters tended to assign lower credit ratings than Japanese ones, but that the relative ratings among raters became similar. Section 6 concludes the paper.

securities excluding stocks accounted for only 3.5% of total liabilities. Their share had decreased to 2.4% at the end of the first quarter of 1974.

Table 11.1

Major Failures and Arrangement of Corporate Bonds

	Company name	Total debts (million yen)	Collection rate (%)	Category of corporate bonds	Arrangement of corporate bonds
Sep-96	Olympics Sports	35,506	N.A.	Publicly-issued CB in Euros	N.A.
Aug-97	Daito Kogyo	159,221	8	Privately-placed SB in Swiss Francs	N.A.
Sep-97	Yaohan Japan	161,383	3	Publicly-issued domestic CB	Purchase of CB at 10% of face values
Oct-98	Morisho	16,121	N.A.	Privately-placed CB in Swiss Francs	Paid full values by using collaterals
Oct-98	Tescon	11,700	40	Privately-placed CB in Euros	N.A.
Dec-98	JDC	406,717	9	Publicly-issued domestic SB and others	10% of face values in the case of an 19 year installment plan
Sep-01	Mycal	1,388,000	N.A.	Publicly-issued Domestic CB and SB	N.A.

Note. CB = convertible bonds, SB = straight bonds.

Source: The authors drew up the table based on Ujiie (2002) and the Institute for Posts and Telecommunications Policy of Ministry of Internal Affairs and Communications (2003).

2. BRIEF HISTORY OF THE SPREAD OF CREDIT RATINGS IN JAPAN

Until the Great Depression in the 1930s, most debentures in the Japanese bond market were issued with no collaterals except foreign bonds issued by Japanese corporations. During this period, conflicts between investors and defaulted issuers were incessant, and financial institutions that undertook defaulted bonds were blamed for being remiss. Therefore, the default disposal procedure in which undertakers ultimately purchased defaulted bonds in place of issuers became a normal practice before the 1930s.

However, the sharp increase of defaults after 1930 made it difficult for undertakers to take over debts. As a result, the commercial law was revised in 1938, and the so-called Rule of Compulsory Collateral was established. The Rule required corporations to use their lands or buildings as collaterals whenever they issued bonds.

After World War II, the Japanese Ministry of Finance (MOF) and the Bank of Japan (BOJ) strengthened investor protection through the establishment of the Qualification Standard for Bond Issuing. This Standard excluded unsuitable issuers from the bond market. To begin with, bond-issuing-suitable corporations were screened through several financial indicators such as the amount of capital stock, net assets and capital ratio. Next, selected qualified corporations were rated into four ranks (i.e., AA, A, BB and B), and the amounts that each company were allowed to issue were dependent on its rank. This ranking system is different from the American type of credit rating system. Japanese ranking was used to select who could issue bonds, while the American type of rating was used to estimate the default risks of bonds.

Bond issuing was not attractive for corporations that had high creditworthiness, because all issuers were charged at almost the same interest rates regardless of their creditworthiness and could not issue what they wanted. Because of this, in the 1970s many Japanese corporations began to issue foreign bonds in the New York, London, and Swiss markets. This trend forced the MOF and the BOJ to consider how to avert the hollowing of the domestic market.

In October 1977, the Securities and Exchange Council, which was an advisory committee of the MOF, published "A Report on What the Japanese Bond Market Should Be", in which the Council advanced that the MOF should liberalize corporate bonds being issued in Japan. Additionally, the Council suggested the need to introduce an American type of rating system into Japan, where outsider institutions without interests for issuers could estimate the abilities of bond issuers to redeem those bonds and inform investors of these results. Furthermore, in the report, the Council proposed the approval of debentures with no collaterals and the establishment of investors' self-responsibilities principle. However, it took a substantial amount of time for the MOF to implement these proposals for bond market reform.

In January 1984, the MOF and financial institutions together organized the Workshop of Debenture Issues, and the Workshop began discussing what roles the American type of raters had played. The Workshop then published their assessment in the report of the US-Japan Dollar-Yen Committee. They made three crucial points in their assessment: (1) that plural rating agencies should be established, (2) the independence of these agencies should be assured, and (3) both issuers and investors should be required to pay rating charges.

It was in 1985 that credit rating agencies as independent organizations began to operate in Japan. During this year, Moody's and S&P opened their offices in Tokyo, and two domestic raters, the Japan Credit Rating Agency (JCR) and Nippon Investors Service (NIS), were established. In addition, the Japan Bonds Research Institute (JBRI) was incorporated in the same year. In July 1987, the MOF

permitted Moody's, S&P, Fitch Investors Service, JCR, JBRI and NIS to assign credit ratings with fees. They were called the Designated Rating Agencies. In October 1992, the MOF added Duff & Phelps, ICBA Ltd., and Thomson Bank Watching to the Designated Rating Agencies.

However, in the first decade of the raters' history in Japan, the Qualification Standard for bond issuing was still in effect. In February 1987, the MOF added a new rating qualification (i.e., "above AA" or "above A with more than 55 billion yen of net assets") to the traditional numerical standards (e.g., 300 billion in net assets and more than 30% of the equity ratio). A corporation satisfying either the new or traditional standards was admitted to issue bonds. However, in June 1990, the numerical standards were abolished, and the rating standard was eased from "above BBB with collaterals" or "above A without collaterals" to "BB with collateral" or "BBB without collaterals" in April 1993. Finally, the Qualification Standard was completely abolished in January 1996. That is, all firms were allowed to issue bonds if the bonds could be sold, and the interest rates were made dependent on the issuers' financial conditions (Yamasawa, 2003).

The abolition of requirements for issuing bonds itself caused several transformations in the Japanese bond markets. Kurosawa (1999) pointed out the following two transformations. First, a firm even in the worst financial situation in principle could issue bonds by paying high interest rates reflecting the risks. Therefore, investors needed to obtain information about the size of risks of issuers. However, investors and analysts found it difficult to obtain relevant information for investment in securities because corporate disclosure was not sufficient at the time when the bond market deregulation was carried out.

Another transformation was that Japanese corporations were now able to issue debentures without obtaining credit ratings. Previously the issuers had been obliged to obtain ratings from one of the Designated Rating Agencies in the case of straight bonds, and from two or more Designated Rating Agencies in the case of CBs. Abolition of this obligation encouraged competition among rating agencies in the markets. As a result, in April 1998, JBRI merged with NIS and restarted as R&I. In addition, the abolition also set off full-scale activities of Moody's and S&P in Japan.

After the overall abolition of the Qualification Standard, the amount of issuing bonds, particularly by high rated corporations, increased because corporations were now able to finance at low costs suitable to their creditworthiness. Figure 11.3 shows the recent development of straight bond markets in Japan. It is apparent that the amount issued sharply increased in the 1990s. R&I (1998) stated "the expansion of the corporate bond market has compensated for the depression of the indirect financial system in Japan to some extent" (p. 59).

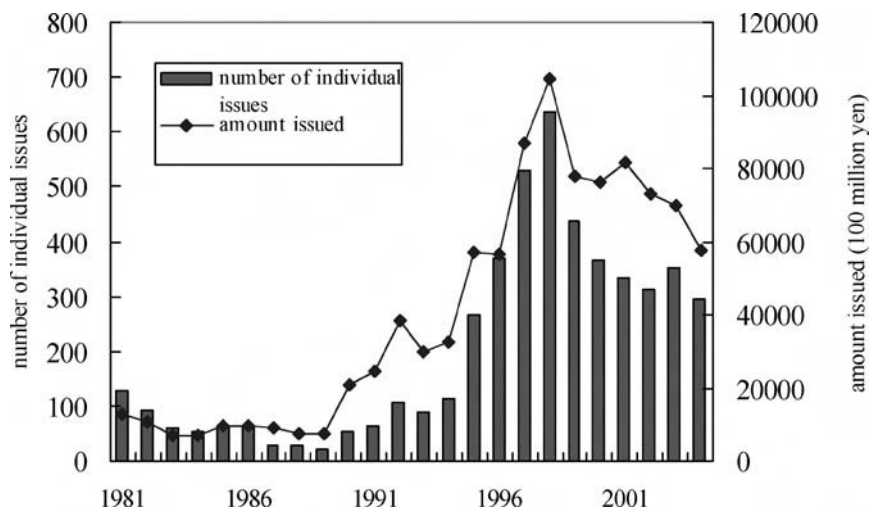


Fig. 11.3. Development of Japanese Straight Bond Markets. Source: Ministry of Finance, Zaimusho Kinyu Tokei Geppou (Domestic Economy)

3. EPOCH-MAKING EVENTS REGARDING CREDIT RATINGS IN JAPAN

3.1. Downgrading and Financial Crisis in 1997

In the late 1990s, large-scale bankruptcies of major banks, securities companies, life and non-life insurance companies, construction and major distribution companies occurred in quick succession. The worst year of this financial crisis was 1997.² In November 1997, several large financial institutions went bankrupt. Sanyo Securities, one of the backbone general securities companies in Japan, collapsed on November 3rd. On November 17th, Hokkaido-Takushoku Bank, one of the Japanese city banks, transferred its management right to Hokuyo Bank and in effect went bankrupt. A week later, on November 24th, Yamaichi Securities, one of the Big 4 securities companies in Japan, announced its decision to voluntarily close its business.

² However, a careful investigation finds that fundamental changes had already realized before the crisis. First, yields in Japanese bank debentures, which used to be the same among all banks, started to depend on issuing banks. Second, the number of bankruptcies steadily increased. Third, in September 1997, a main bank of Yaohan Japan rejected to take up Yaohan's CBs after its bankruptcy. It was the first default that occurred in Japanese *publicly-issued* domestic bond market since the end of World War II.

There was criticism that credit ratings intensified the crisis. On November 21st, Moody's announced it was downgrading Yamaichi Securities' unsecured CB's rating from Baa3 to Ba3. On the other hand, despite maintaining Yamaichi's rating at BBB-, S&P announced it was putting Yamaichi on negative lists and would possibly downgrade Yamaichi's rating. Moody's gave the following reasons for downgrading Yamaichi: (1) Yamaichi had lost market trust, (2) it had declined in financing ability, and (3) its capital position had become fragile. The day after this announcement, although the chief of MOF's Bureau of Securities announced that Yamaichi was not insolvent despite more than 200 billion yen of off-balance-sheet liabilities, participants in the inter-bank markets took the downgrade by Moody's seriously, and stopped lending to Yamaichi entirely. Two days later, Yamaichi's board of directors unanimously decided to close their business.

3.2. Downgrading of Japanese Government Bonds

Credit ratings on Japanese government bonds (JGBs) are important issues for Japan, because the total debt held by the Japanese government amounted to 751 trillion yen as of March 2005. If the interest rates of JGBs increase by 1% due to the downgrading of credit ratings, the government will have to pay an additional 7.5 trillion yen, which is one-sixth of the annual tax revenue of the government.

In April 1998, Moody's changed the yen-denominated JGBs ratings from Aaa stable to Aaa negative. Moody's simply explained that uncertainty had increased as to whether it would be possible for the Government to achieve its central aims, economic growth and fiscal improvement. In June 1998, Moody's released a detailed report analyzing the Japanese economy. This report emphasized three factors destabilizing the Japanese economy: fiscal deficits, surplus in the balance of payments, and deflationary pressure. Eventually, Moody's downgraded yen-denominated Japanese Government Bonds to Aa1 in November 1998, to Aa2 in September 2000, to Aa3 in December 2001, and A2 in May 2002. Similarly, S&P downgraded yen-denominated JGBs from AAA to AA+ in February 2001, to AA in November 2001, and to AA- in April 2002. Fitch also downgraded yen-denominated JGBs from AAA to AA+ in June 2000, to AA in November 2001, and to AA- in November 2002.

As of August 2005, yen-denominated JGBs have been assigned A2 ratings by Moody's. Among the G-7 countries, Japan has the lowest ratings and the second lowest is Italy with Aa2, which is 3 notches higher than A2. Other G-7 countries have AAA grade ratings. Countries that have been given the A2 grade include Israel, South Africa, Poland, Mauritius, Kuwait and Latvia. It is true that the Japanese government is having financial difficulties. Its tax revenue only covers approximately half of its expenditures, and about one-fifth of these expenditures

consist of interest payments for JGBs issued in the past. In addition, if interest rates increase, then the government will be unable to pay the interest. Furthermore, to judge the creditworthiness of a country, the independence of its central bank is an important factor, because the expected inflation rate affects sovereign risks. Despite the new Bank of Japan Law, Japan is still regarded as not having a completely independent central bank (Iwasaki, 2004).

However, the MOF was not satisfied with the decision by Moody's and claimed that "considering the strong fundamentals of the Japanese economy, the current ratings of JGBs are already too low and any further downgrading is unwarranted. Your explanations regarding rating decisions are mostly subjective in nature and lack objective criteria, which invite questions about the reliability of rating itself".³

Unlike with private corporations, it is difficult for sovereign ratings to be statistically confirmed through default experiences. Kurosawa (1999) indicated that compared with the credit ratings of private firms, the correlation between the sovereign ratings given by Moody's and those by S&P were lower. In addition, in the case of the monetary crisis in Asia in 1997, raters changed the sovereign ratings of Asian countries four or five times within one year. Ferri, Lui and Stiglitz (1999) insisted that it was credit rating agencies that aggravated the Asian monetary crisis.

4. JAPANESE RATING AGENCIES

4.1. General Characteristics of Japanese Rating Agencies

As we mentioned above, in 1984 the Workshop of Debenture Issues pointed out that independent rating agencies were necessary and that both investors and issuers should pay rating costs. According to the "independence" criterion, credit rating agencies are required not to have any capital and creditor-debtor relations with financial institutions that have interests in bonds issuing or bond-related administrations. For example, if a securities company dealing with bond issuing was a major stockholder of a rating agency, that agency might be lenient in rating bond issuers who are clients of that securities company.

Despite the Workshop's proposal, the MOF decided in 1985 that credit rating agencies were required to be capitalized by financial intermediaries and securities firms because the experiences of bankers in terms of screening long-term-lending and of analysts in securities firms in terms of underwriting bonds were necessary

³ See <http://www.mof.go.jp/jgb.htm>.

in order to assign appropriate credit ratings to long-term bonds. The MOF maintained that conflict of interest problems were avoidable by setting a subscription limit per investor within 5% of the entire capital. Although the MOF's decision was understandable given the circumstances of the 1980s, the capital structure of Japanese rating agencies has not been improving since then. As a result, more than half of the stocks of JCR and more than 40% of R&I are still occupied with financial institutions, including banks, securities companies and insurance companies. As the U.S. Securities and Exchange Commission has not accepted the Japanese MOF's decision, JCR and R&I cannot sell their rating information in the United States.

The issue of "who pays rating costs" is also important, because a rating agency could rate so as to give the payer an advantage. If only investors were to pay the costs, the ratings could tend to be stricter. However, if only issuers pay the costs, the rating could be prone to be favorable to the issuers, who wish to finance at lower interest rates. Accordingly, as in the U.S., the Workshop of Debenture Issues thought that both investors and issuers should pay the costs to make the ratings fair. However, at that time in Japan, several institutional investors insisted that they had disagreed about paying for rating information to rating agencies because firms that were in bad financial condition were not permitted to issue debentures, and because credit ratings at that time had no information value. Consequently, the MOF decided that only issuers would pay rating costs for the time being, and investors would be required to pay the costs after the necessary conditions would have been arranged. Although more than twenty years have passed, the system still remains unchanged in 2005.

Additionally, it is notable that there are two large differences between Japanese agencies and U.S. agencies in terms of rating operation. First, agencies in the United States value disclosed information such as financial statements, while Japanese agencies tend to put a high value on non-public information acquired through private interactions with firms. It is generally true that the financial soundness of Japanese corporations presented through disclosed data such as ROE, the equity ratio and liquidity ratio is inferior to that of U.S. corporations. Therefore, the ratings of U.S. agencies that put a high value on financial statements necessarily tend to be stricter for Japanese firms. Japanese rating agencies consider "qualitative information" as well as financial statements. For example, they think that the cross-holdings of equities, main-banks relations, keiretsu affiliations, a convention of priority payments in debenture or the government's back-ups are not shown in the balance sheet but enhance the firm's creditworthiness. It is quite

natural that the ratings of Japanese raters which consider these factors are higher than those of American raters.⁴

Second, Japanese agencies are slower to downgrade firms than U.S. agencies.⁵ Foreign raters anticipate the outcome of the event and change ratings in advance, while Japanese raters keep ratings unchanged until the actual effect of the event emerges. When a situation is deteriorating, Japanese raters tend to be slow to downgrade. Therefore, Japanese raters assigned inevitably higher rates than U.S. raters during the burst of the bubble period.

In the following sections, because Moody's and S&P are well known to international readers, we would like to give a detailed explanation of Japanese credit rating agencies.

4.2. Japan Credit Rating Agency (JCR)

Japan Credit Rating Agency (JCR) was established in April 1985 and capitalized by life and non-life insurance companies, trust banks, regional banks and long-term credit banks. In November 1985, it began to publish "JCR Reports", and in the next year, it started pay-rating on yen-denominated foreign bonds.

At the end of FY 2003, the ratings of JCR covered the 64.4% (590 firms) of Japanese firms which had obtained credit ratings. Its covering rates were especially high in the financial business (69.8%), distribution industry (71.9%) and non-manufacturing industry (73.9%).⁶ JCR has more actively rated foreign firms than R&I. Therefore, it has promoted business tie-ups with foreign rating agencies such as the SCI in Korea (August 2000) and the DCR-VIS in Pakistan (January 2001).

JCR does not execute non-requested ratings as a rule. JCR is considered superior to U.S. rating agencies in that JCR publishes their reports in Japanese as well as in English, and its analysts have constructed better and more loyal relations with Japanese firms and institutional investors than U.S. agencies through closer

⁴ However, there is a counter-evidence to this argument. Shin and Moore (2003) found that despite clear difference in rating between Japanese raters (JCR and R&I) and U.S. raters (Moody's and S&P), the rank correlations were relatively high. And they estimated ordered probit models to test whether each of the four agencies considered keiretsu affiliation. For non-financial firms, keiretsu affiliation negatively affected its rating for one U.S. agency and one Japanese agency. And for financial firms, both U.S. agencies assessed keiretsu affiliation positively, while Japanese agencies did not.

⁵ Of course, even U.S. raters are often criticized because a firm that was rated above BBB went bankrupted. Ratings are less prompt in reflecting new information than other market variables such as stock prices. For example, Bongini, Laeven and Majnoni (2002) supported previous findings that credit rating agencies have been slow in adjusting their ratings for the East Asian banks during the onset of the East Asian crisis.

⁶ See <http://www.jcr.co.jp/information/puroh.htm>.

contacts with them. Moreover, JCR examines and monitors Japanese firms more carefully and cooperatively than U.S. agencies, and tries to describe Japanese firms more comprehensively than foreign analysts (Fight, 2003).

However, this agency has several faults. In particular, we cannot disregard the fact that it is capitalized by about one-hundred financial institutions. Formerly JCR employed many analysts coming from these institutions, and it was reasonably wondered whether they could properly rate the institutions they had formerly been employed by. Of course JCR now employs many analysts who have no relation with the financial institutions, but this independence problem still remains. In addition, JCR was criticized for its rating ability because it assigned BBB to Mycal Co., a major retailer in Japan, in October 2000, but it went bankrupt in September 2001.

4.3. Rating & Investment Information (R&I)

Rating & Investment Information (R&I) originates from the Institute of Public and Corporate Bonds established within Nihon Keizai Shinbun, Inc. (a major business newspaper) in March 1975. In 1978, the Institute published the first ratings of listed CBs in the newspaper, and tentatively started rating new CBs. The following year, the rating operations were transferred from an in-house sector of the newspaper company to a private organization, Japan Bonds Research Institute (JBRI). JBRI was incorporated in April 1985 and started new rating services such as shogun bond ratings. Another Japanese rating agency, Nippon Investors Service, Inc. (NIS) was born that same April. This agency was capitalized by the Industrial Bank of Japan, city banks, trust banks, regional banks, life and non-life insurance companies, and a think tank established by a securities company and a press company. NIS published the first issue of the NIS Rating Information (in Japanese) in February 1986.

In April 1998, R&I was established through the merger of JBRI and NIS.⁷ Nihon Keizai Shinbun, Inc. and its subsidiaries hold fifty-six percent of the stocks of R&I, and various financial institutions hold the rest. Therefore, this agency has the same independence problem as JCR due to the structure of its stockholders.

At the end of October 2002, R&I rated 705 firms. It has also promoted business tie-ups with foreign rating agencies such as Fitch Ratings and NICS (an investment information company in Korea). Furthermore, R&I has been urged to extend its rating services to academic institutions, local governments, and special public corporations.

⁷ See <http://www.r-i.co.jp/eng/company/history.html>.

4.4. *Mikuni & Co., Ltd.*

Unlike JCR and R&I, Mikuni & Co., Ltd. is a rating agency without the designation of the MOF. It was established in 1975, and began offering financial analyses. It began issuing credit ratings in 1983. In the beginning, its main business was supplying foreign investors with information about Japanese firms issuing bonds in foreign countries. Now Mikuni's credit ratings cover 1500 Japanese firms.⁸ This number is far above those of other rating agencies in Japan.

The distinguishing characteristic of Mikuni is that it has no business tie-up with any outsiders, and is completely free from any direction from and regulation by the government. One of Mikuni's corporate philosophies is to keep itself independent from any companies, bond issuers, financial institutions, brokers and government authorities because such independence enables it to form and express its opinions freely and objectively.⁹

Other characteristics of Mikuni's credit ratings are as follows. In contrast to designated agencies (i.e., JCR and R&I), Mikuni earns rating charges only from investors, not from issuers, and utilizes only disclosed information. In addition, it doesn't use the sovereign ratings of foreign firms to estimate each debenture. In other words, in terms of the usage of sovereign information, Mikuni is not only different from Japanese rating agencies, but from U.S. agencies, and thus Mikuni does not change ratings easily when unexpected events such as natural disasters or acts of terrorism occur.

Mikuni & Co., Ltd. is also well known as the strictest rater of Japanese firms. For example, it was Mikuni that first assigned different ratings among long-term credit banks in Japan. At the end of October 2003, the ratio of investment grade to speculative grade was 1 to 2, which was far stricter than those of Moody's and S&P at the same point in time.

5. AN EMPIRICAL INVESTIGATION OF JAPANESE CREDIT RATINGS

5.1. *Overview of Straight Bond Market*

As discussed in the Introduction, bond issuance is not a primary source of outside funds for average Japanese firms. It is apparent that small firms cannot issue bonds because of information problems and large fixed expenditures. However, owing

⁸ See <http://www.mikuni-rating.co.jp/jp/jpcompany/framepagecompany.html>.

⁹ See <http://www.mikuni-rating.co.jp/eng/encompany/enframepagecompany.html>.

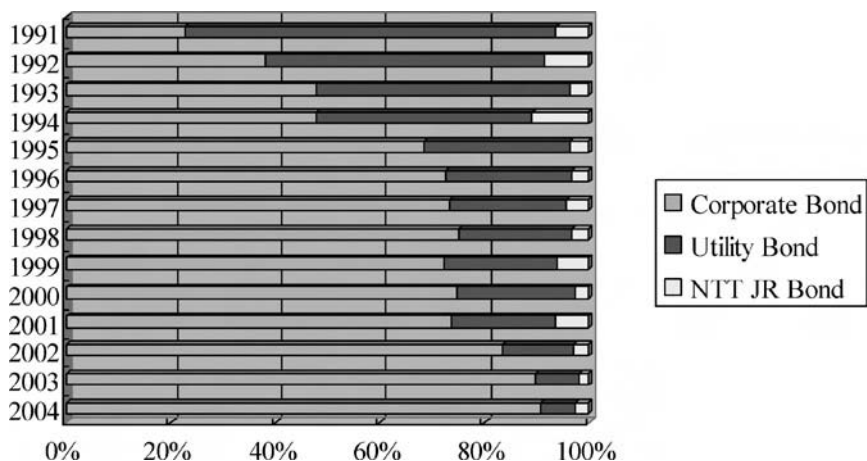


Fig. 11.4. Bonds Issuing by Issuers. *Note.* NTT is Nippon Telegraph and Telephone Corporation, and JR is Japan Railways. Both of them used to be state-owned firms. Source: Ministry of Finance, Zaisei Kinyu Tokei Geppou

to deregulation, it is notable that large firms have increased their dependency on bonds.

In addition to the increase in the volume of bond issuance, there has been an important change. Namely, various kinds of firms now issue bonds. During the regulated period, the share of utilities companies in the bond issue market was very large. In the 1990s, as shown in Figure 11.4, the importance of utility companies as bond issuers decreased because their demand for funds significantly decreased.

Along with these developments, credit ratings and rating agencies are playing an increasingly important role in Japanese financial systems. We will investigate the actual credit rating practices in Japan and answer the following questions: (1) Raters shares: How has the share of each rating agency changed over times? (2) Multi-ratings: What kind of rater combination is popular? Who obtains multiple ratings? (3) Differences in ratings among raters: Are there any differences in ratings among raters? How have the differences changed over time?

5.2. Data

Here, we collected the ratings assigned at the time that new publicly-offered straight corporate bonds were issued. We obtained the data for FY 1993 and FY 1996 from Koshasai Nenkan (Public Bond Yearbook) and for FY 2000 and FY

2004 from the website of Shokengyo Kyoukai (Japan Securities Dealers Association, or JSDA). Although some companies issued corporate bonds several times in one year, we counted each as a different issuance. Anecdotally, we attempted to analyze credit ratings in the 1980s, but there was no available data on the ratings of corporate debts in the 1980s.¹⁰

5.3. Results

5.3.1. Who Gains a Share in the Rating Market? There were five qualified rating agencies in Japan before 1998 and four rating agencies after 1998, when JBRI and NIS were merged into R&I.¹¹

Firms can issue bonds with obtaining credit ratings from one rater.¹² However, in practice, firms often obtained credit ratings from two or more credit rating companies. Table 11.2 shows the distribution of multiple ratings regarding straight bond issuance.

In 1993, more than 60% of issuances were with single credit ratings. That ratio decreased to 40% in 1996. We should note that the figures in 2000 and in 1996 were not directly comparable, because of the merger of JBRI and NIS. If a firm obtained credit ratings from JBRI and NIS in 1996 and from R&I in 2000, the firm was classified into the multi-rater category in 1996 and the single-rater category in 2000. The ratio of single-rater categories for 2000 and 2004 are almost the same (i.e., around 55%). Thus, currently, approximately half of issuers obtain credit ratings from two or more raters. However, it is also notable that very few companies obtain credit ratings from all four raters. In other words, firms choose their raters.

Table 11.3 shows which raters were chosen by issuers. In 1993, 56 firms chose JBRI as a rater. Only 10 companies obtained ratings from JCR in 1993. In 1996, Moody's was the top among the five raters, followed by JBRI. In 2000, R&I was the top, followed by JCR. The number of bonds with ratings from Moody's significantly decreased. In 2004, R&I assigned credit ratings to 202 issuers. This means that 73.4% of issuers obtained rating from R&I. In contrast, American raters lost their market shares in 2004. Moody's covered 51.8% of issuers in 1996, while

¹⁰ This is an indicator that credit ratings were not important in the 1980s.

¹¹ Although Fitch and Mikuni also operate in Japan, our data source does not contain any information about ratings of these raters.

¹² Strictly speaking, a firm now can issue bonds without credit ratings. However, our data source does not contain bonds issuance without credit ratings. For example, as JSDA reported that 307 straight corporate bonds were issued in FY 2004 and our data source identified 297 bonds, at most 10 bonds were issued without ratings. Based on the similar calculations, we find that 0 for 1993, 7 for 1996, and 17 for 2000 were issued without ratings.

Table 11.2
Number of Raters

	1993	1996	2000	2004
1 rater	54	144	189	165
2 raters	24	190	104	100
3 raters	6	22	46	27
4 raters	4	7	11	5
Total	88	363	350	297

Table 11.3
Which Rating Company Did Firms Choose?

Rating	R&I		Moody's	S&P	JCR
	JBRI	NIS			
1993	56	32	30	8	10
1996	182	117	188	30	101
2000	250		72	67	190
2004	218		50	28	170

it covered only 16.8% in 2004. Thus, it is apparent that Japanese rating firms increased their influence in Japanese financial markets.

5.3.2. Who Jointly Assigns Ratings? As shown in Table 11.2, about half of issuers obtained credit ratings from two or more credit raters in 2004. It is interesting to investigate what kind of combinations were popular and how those combinations changed over time. For example, if American raters' ratings are valuable for international investors and Japanese raters' ratings are valuable for domestic investors, firms that want to sell bonds both in international and domestic markets need to obtain credit ratings from both American and Japanese raters.

In 1993 and 1996, as there were five raters, there were 10 two-rater combinations.¹³ In 2000 and 2004, there were six combinations. Table 11.4 shows the results for 1993 and 1996. The combination between JBRI and Moody's (MDY) was the most popular in 1993 and 1996, followed by the combination between NIS and Moody's. Table 11.5 shows the results for 2000 and 2004. In contrast to the previous years, R&I-JCR combination was the most prevalent in 2000 and 2004. To put it another way, a Japanese-American combination was popular be-

¹³ Regarding triple ratings (such as JCR, Moody's and S&P), we identify three two-rater combinations; JCR-Moody's, Moody's-S&P, and JCR-S&P.

Table 11.4
Combinations of Raters for 1993 and 1996

	JBRI NIS	JBRI MDY	JBRI S&P	JBRI JCR	NIS MDY	NIS S&P	NIS JCR	MDY S&P	MDY JCR	S&P JCR
1993	12	22	7	0	13	4	0	8	0	0
1996	21	103	24	14	80	9	3	11	30	3

Table 11.5
Combinations of Raters for 2000 and 2004

	R&I MDY	R&I S&P	R&I JCR	MDY S&P	S&P JCR	MDY JCR
2000	47	46	99	54	35	27
2004	39	19	96	23	22	12

Table 11.6
Combinations of Rating Agencies

	Both Japanese rating companies	Japanese and U.S. rating companies	Both U.S. rating companies
1993	12	46	8
1996	24	263	11
2000	99	155	54
2004	96	92	23

fore 2000, but a Japanese–Japanese combination became popular after 2000 (see Table 11.6). Thus, this is consistent with the argument that the roles of Japanese rating agencies become more and more important in the 2000s.

5.3.3. Who Obtains Multiple Ratings? There is a possibility that multiple ratings may be effective in mitigating information asymmetries. If so, a firm that suffers from larger asymmetric information problems will more likely obtain multiple ratings. However, multiple ratings may not make any difference, or make matters even worse because firms have to pay to obtain multiple ratings.

We investigated what factors encouraged issuers to obtain multiple ratings by using the 2004 data. More concretely, we tested whether the amount issued, maturity, and interest rates were related with the number of ratings. For example, when a firm issued larger amount of corporate bonds and increased the leverage ratio,

Table 11.7

Relationship between the Number of Ratings, Amount of Bonds Issued, and Maturity and Interest Rates in 2004

	1 rating	2 ratings	3 ratings
Amount of issue			
Not over 100 million	90	54	8
100–200 million	21	8	1
200 million and above	56	38	19
Average (million yen)	169.42	192.81	204.17
Median (million yen)	100	100	125
Maturity			
Not over 5 years	78	42	9
5–10 years	38	19	1
10 years and above	51	39	17
Average (years)	7.29	8.99	8.17
Median (years)	6	10	10
Interest rate			
Not over 0.75%	21	17	6
0.75–1.5%	79	38	6
1.5% and above	50	34	14
Average (%)	1.31	1.48	1.29
Median (%)	1.29	1.55	1.29

Note. The figures in the rows except Average and Median depict the number of issues that fall under the category.

information asymmetries became worse. Such an issuer has an incentive to obtain multiple ratings to reduce information asymmetries.

Table 11.7 shows how the number of credit ratings is related to the amount issued, maturity and interest rate. First, when a firm issues bonds that are worth a high amount, the firm tends to obtain two or more ratings. Second, the average maturity for bonds with one credit rating is 7.29 years, while it is 8.17 years for bonds with three credit ratings. Although bonds with two credit ratings have a longer maturity period than those with three ratings, a firm that issues bonds with longer maturity tends to obtain more credit ratings. Finally, there is no apparent relationship between the number of raters and interest rates. As multiple ratings alleviate the information problems, interest rates obtained by using multiple ratings would be lower than those obtained without multiple ratings. However, if the firms that have large asymmetric information problems choose multiple ratings, then the interest rates of bonds with multiple ratings will tend to be high. Therefore, these cross-interactions may make the relationship between the number of raters and interest rates ambiguous.

Table 11.8
Simple Average of Ratings by Raters

Rating	R&I		MDY	S&P	JCR
	JBRI	NIS			
1993	2.70	2.31	5.19	1.88	6.13
1996	4.22	4.49	7.46	4.87	6.19
2000	4.54		5.03	5.42	4.84
2004	5.40		5.43	5.31	5.23

Note. JBRI and NIS merged into R&I in 1998.

These results are consistent with the hypothesis that credit ratings are used to mitigate information problems. Of course, it should be noted that our results are tentative, because the data we used here was only for 2004. In addition, we need to conduct a more formal test in which several factors are controlled to reach a definitive conclusion.

5.3.4. How Do Credit Raters Assign Different Ratings? As Shin and Moore (2003) pointed out, credit rating standards are different among raters. Here, we will first investigate how different the raters' standards are. Following Morgan (2002), who assigned each credit rating a numerical number, such as AAA = 1, AA+ (or Aa1) = 2 and AA (or Aa2) = 3, we calculated the average ratings for each rater.

The results are shown in Table 11.8. In 1993, the average S&P rating was 1.88. As this means that most companies had AAA or AA+ ratings from S&P, S&P rated only highly solvent companies. The averages of Moody's and JCR were 5.19 and 6.13, however, suggesting that they rated companies having relatively lower creditworthiness, if the rating standards were the same among these raters. While the difference in the average ratings between rating companies was relatively large in 1993, the difference became smaller in 2000 and 2004. Namely, the average ratings ranged from 4.54 to 5.42 in 2000 and from 5.23 to 5.52 in 2004.

Following the argument of Morgan (2002), the convergence of credit ratings is a signal of an improvement in the information problems. Thus, due to the disclosure and accounting reforms enacted since the late 1990s, we can tentatively conclude that credit rating companies can evaluate the creditworthiness of issuers much more precisely than before.

However, an important question must be posed. Are the criteria of rating companies really the same? For example, Tokyo Electric Power Co. obtained a rating of AAA from JCR, AA+ from R&I, and AA- (Aa3) from S&P and Moody's in 2004. Similarly, JFE (a major steel maker) obtained a rating of A+ from JCR,

Table 11.9

Average Ratings for Overlapped Firms

	JBRI	NIS	JBRI	MDY	JBRI	S&P	JBRI	JCR	NIS	MDY
1993	2.000	1.667	2.545	4.727	1.286	2.000	N/A	N/A	1.923	4.692
1996	3.800	3.600	3.653	6.535	2.500	4.125	4.929	6.643	3.823	7.329
	NIS	S&P	NIS	JCR	MDY	S&P	MDY	JCR	S&P	JCR
1993	1.000	1.250	N/A	N/A	1.750	1.875	N/A	N/A	N/A	N/A
1996	2.000	4.333	6.000	10.000	2.364	4.818	9.600	5.033	10.667	6.000

	R&I	MDY	R&I	S&P	R&I	JCR	MDY	S&P	S&P	JCR
2000	4.361	3.588	2.565	4.978	4.361	3.588	5.000	5.760	4.795	1.846
2004	3.471	5.824	3.286	5.500	5.473	4.516	4.727	5.409	6.167	2.417
	MDY	JCR								
2000	5.087	1.565								
2004	5.300	2.100								

A— from R&I, and BBB— from Moody's in 2004. Thus, there was a difference of three notches for Tokyo Electric Power and five notches for JFE. This suggests that bond rating agencies still have different criteria.

To consider the difference in criteria, we will focus on firms that obtained more than two credit ratings (which we call “overlapped firms” below). As explained above, there were ten combinations of raters for 1993 and 1996 and six combinations for 2000 and 2004. However, several combinations had no overlapped firms. For example, there were no firms that obtained credit ratings from both JCR and S&P in 1993.

First, we calculated the average credit ratings for overlapped firms regarding each combination of raters. The results are shown in Table 11.9. For example, in terms of the combination between JBRI and NIS, there were 12 overlapped firms in 1993. We found that the average ratings of JBRI and NIS for these 12 firms were 2.00 and 1.67, respectively. The results show that there are significant difference among Japanese raters and American raters. For example, there was a difference of 2.2 notches in 1993 and 2.9 notches in 1996 between JBRI and Moody's. More apparently, there was a difference of 2.8 notches in 1993 and 3.5 notches in 1996 between NIS and Moody's. Even in 2004, there were large differences between Japanese and American raters. Specifically, there were 3.4 notches difference in 2004 between JCR and Moody's.

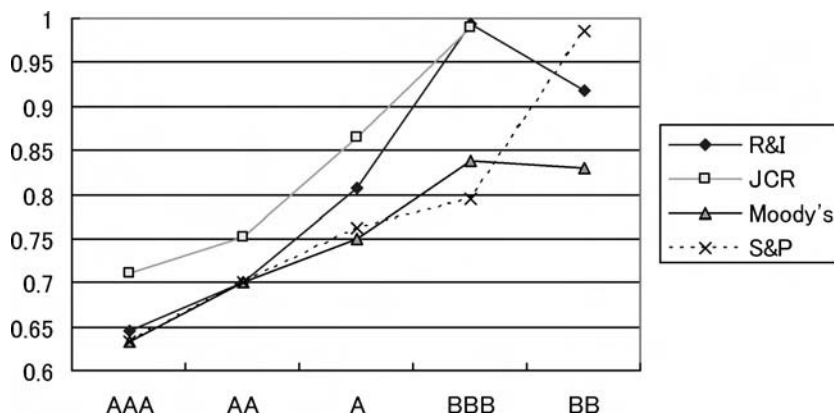


Fig. 11.5. Difference in Interest Rates for the Same Credit Ratings among Raters

In sum, Japanese raters assigned more favorable credit ratings than American raters. As the difference is about three notches, a firm with a credit rating of A+ from a Japanese rater will obtain a credit rating of BBB+ from American raters. The bond market reflects this difference. For example, as shown in Figure 11.5, interest rates of bonds with a BBB rating from S&P and Moody's are almost the same as those with an A from R&I and JCR.

It could be argued that absolute differences among raters may not be important, because we can adjust for the differences. However, if a Japanese rater regards Firm A as more solvent than Firm B, and a U.S. rater regards Firm A as less solvent than Firm B, market participants will find it difficult to evaluate relative creditworthiness between these firms. If raters are similar in terms of evaluating relative creditworthiness among firms, the correlation coefficients of ratings should be high. Therefore, we calculated the correlation coefficients.

Tables 11.10a–d show that simple correlation coefficients regarding overlapped firms have become larger over time. The correlation coefficients between JBRI and NIS were 0.934 in 1993 and 0.986 in 1996. This suggests that these two Japanese raters used very similar rating criteria. The coefficients between S&P and Moody's were 0.701 in 1993 and 0.718 in 1996. This suggests that American raters used slightly different rating criteria. Although the correlation coefficient between JBRI and Moody's was very high (i.e., 0.972) in 1993, the correlation coefficients between American raters and Japanese raters were generally small. Namely, the correlation coefficient between JBRI and S&P was 0.441 in 1993 and that between NIS and Moody's was 0.673 in 1993. The results for 1996 were the same as for 1993. The correlation coefficient between JBRI and NIS was very high (0.986), and the correlation coefficients between American raters and Japanese

Table 11.10a
Simple Correlation Coefficient in 1993

	JBRI	NIS	MDY	S&P	JCR
JBRI	1.000				
NIS	0.934	1.000			
MDY	0.972	0.673	1.000		
S&P	0.441	N/A	0.701	1.000	
JCR	N/A	N/A	N/A	N/A	1.0000

Table 11.10b
Simple Correlation Coefficient in 1996

	JBRI	NIS	MDY	S&P	JCR
JBRI	1.000				
NIS	0.986	1.000			
MDY	0.877	0.755	1.000		
S&P	0.912	N/A	0.718	1.000	
JCR	0.494	N/A	0.691	N/A	1.000

Table 11.10c
Simple Correlation Coefficient in 2000

	R&I	MDY	S&P	JCR
R&I	1.000			
MDY	0.906	1.000		
S&P	0.798	0.644	1.000	
JCR	0.936	0.785	0.959	1.000

Table 11.10d
Simple Correlation Coefficient in 2004

	R&I	MDY	S&P	JCR
R&I	1.000			
MDY	0.912	1.000		
S&P	0.884	0.964	1.000	
JCR	0.961	0.783	0.874	1.000

ratings ranged from 0.755 to 0.912. However, JCR was an exception. Judging from the fact that JCR ratings were not closely related with the other raters' ratings, JCR used a different criteria.

In 2000, the correlation coefficients of JCR with the other raters became higher than before. The lowest value was found in terms of the combination of S&P and Moody's. This suggests that there were strong disagreements about Japanese firms' creditworthiness between American raters. In 2004, all correlation coefficients in 2004 except between JCR and Moody's were close to one. In particular, the correlation coefficients between Japanese raters (i.e., JCR and R&I) and those between American raters (i.e., Moody's and S&P) were very high. That is, these results in Tables 11.10a–d are consistent with the argument that corporate disclosure reforms in the late 1990s have brought more accurate ratings, but there are some differences in rating criteria between Japanese and American raters.

6. CONCLUDING REMARKS

In this paper, we pointed out the increasing role that credit ratings are playing in Japan. However, there are a lot of problems with ratings that remain to be solved. One issue concerns American raters in Japan. In Japan, American raters are strongly criticized because people suspect that Moody's and S&P assign inappropriately low ratings to Japanese issuers. The actual default rates in the Japanese market do not seem to support these low ratings. Annual data released by Moody's and S&P show that their ratings are closely related with actual default ratios, but this only means that their ratings of U.S. companies are closely related with actual default ratios, and does not mean that their ratings of Japanese companies are also closely related with actual default ratios.

Japanese managers are often unsatisfied with the reasons given for downgrading by American raters, because they feel that American raters do not understand business practices in Japan. For example, according to Fight (2003), Moody's degraded the rating of Toyota Motor Corporation from AAA to Aa1 in 1998 on the grounds that competition in the global automobile market is intensifying, and Toyota's competitiveness has weakened due to its practice of giving workers lifetime employment. In refuting Moody's, Mr. Okuda, the CEO of Toyota Motor Co., argued that the lifetime employment system was not a burden for Toyota because it had adopted a flexible employment structure. Eventually, Moody's upgraded Toyota's rating from Aa1 to AAA in 2003.

Furthermore, Fight (2003) pointed out the fact that none of twenty-five Japanese corporations that Moody's assigned speculative grades to before 1998 had defaulted as of October 2003, while the probability that firms rated Ba by Moody's would default within five years was 11.4 per cent. He pointed out that

Moody's might have disregarded specific factors in the Japanese market (e.g., mainbank relations) which lower default rates.¹⁴

There are also deep-rooted complaints against "unrequested ratings" by U.S. agencies in the Japanese bond market. In terms of unrequested ratings, there is a slight difference between S&P and Moody's. S&P clearly distinguishes "requested" and "unrequested" ratings for investors because investors recognize that unrequested ratings rely on less information or less reliable information than requested ratings. In contrast, Moody's insists that they are able to maintain the same quality for unrequested ratings as requested ones, so Moody's doesn't disclose the distinction at all.

Although there is considerable evidence that American raters are not always right, there are also serious problems with Japanese raters. As mentioned in Section 4, except for Mikuni & Co., Japanese credit rating agencies are not independent from issuers and financial institutions. Namely, JCR and R&I are still substantially capitalized by financial institutions. In addition, these Japanese raters earn rating charges only from issuers. In other words, investors are not the customers of these raters. In fact, except for Mikuni, Japanese raters tend to assign better ratings to Japanese issuers than American raters. It is necessary to investigate whether the capital structure and business practices of Japanese raters distort their rating decisions.

Finally, we should point out that Japanese investors may not fully understand the meaning of rating grades. The Japanese mass media often state that a rating below BBB- is considered an "inadequate to invest" grade, not a "speculative grade", and Japanese investors also accept this interpretation. Therefore, in the Japanese market, once a firm is rated below BBB-, the firm can no longer obtain necessary funds. However, "a speculative grade" doesn't mean that people shouldn't purchase the firms' bonds, but just means that there are relatively high risks to purchasing the bonds and a high expected return. Therefore, Japanese investors need to be educated on how to use credit ratings properly.

Thus, although credit ratings play a very important role in Japan, much remains to be done before credit ratings can be considered reliable and before they can be properly used in Japan.

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¹⁴ However, as he noted, such factors would be going to weaken due to the deregulations and globalization.

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Interest Rate Analysis

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Chapter 12

MULTIFRACTAL MODELING OF THE JAPANESE TREASURY TERM STRUCTURE

Sutthisit Jamdee and Cornelis A. Los

Abstract

This paper identifies Multifractal Models of Asset Returns (MMARs) for each of the eight nodal term structure series of monthly Japanese Treasury rates and, after proper synthesis, simulates those MMARs. All nodal rate series are found to be slightly anti-persistent, with the exception of the 20-year rate which is heavily anti-persistent and in the range of being chaotic. This contrasts with our earlier findings of the US term structure (Jamdee and Los, 2007), where the US interest rates are identified to be slightly persistent, although that model identification was based on daily data. The simulations of the identified Japanese interest rate MMARs are compared with the original empirical time series, and also with the simulated results from the corresponding Geometric Brownian Motion (GBM) and GARCH processes. All eight different maturity Japanese Treasury rates are found to be multifractal processes. Identified distributions of all simulated processes are compared with the empirical distributions in both snapshot and time-scale (-frequency) analyses. Using wavelet scalograms, we demonstrate that the MMAR does not clearly outperform either the GBM and GARCH(1, 1) in time-frequency comparisons. The simulated MMAR replicates all attributes of the short maturity empirical distributions, while the simulated GBM and GARCH(1, 1) processes perform better for the long maturity series. Nevertheless, these results are somewhat inconclusive since the MMAR experiences difficulty with the simulations of these anti-persistent, and in one case, possibly chaotic, price diffusion processes.

1. INTRODUCTION

Interest rates are some of the most important variables in finance. A change in interest rates can have a substantial impact on asset investments and derivatives

pricing. Therefore there is considerable demand for well-identified interest rate models. The current discussion about interest rate models in the financial literature can be summarized as follows.

Most financial market models consist of an affine (= “linear in coefficients + intercept”) mathematical system driven by an exogenous, market news, information process. Thus far most information processes are assumed to be either i.i.d. processes in discrete-time Wald-type models, or Wiener–Gauss processes in continuous time models. However, very recently the mono- and multi-fractal information processes of Mandelbrot have again become popular, after their initial popularity in the late 1960s and early 1970s. In addition, there is some discussion of nonlinear continuous time models driven by Wiener–Gauss processes (see, for example, Franke, Stapleton and Subrahmanyam, 1999). In this paper we will discuss the affine models driven by either i.i.d./Wiener–Gauss or fractal information processes and leave the comparison with the nonlinear models driven by i.i.d./Wiener–Gauss information processes for another paper.

The very first dynamic interest rate model, known as an one-factor affine model, driven by an i.i.d. information process, was introduced by Vasicek (1977). Since then several models have been proposed, ranging from the very simple to the very complex, in terms of the number of factors or information processes employed. Such one- or two-factor models of interest rates are preferred, since they can succinctly explain most of the variation of the term structure of interest rates. The majority of these simple factor models assume Geometric Brownian Motion (GBM) with trend as their price diffusion process. This is not a coincidence, since it is imperative for transparency and scientific logic that the proposed models are tractable. In addition, sophisticated investors prefer the GBM, as many are already familiar with it from the 1973 Black–Scholes European options pricing formula.

But accumulating evidence in the academic financial literature indicates that these GBMs cannot explain several salient features of the empirical financial data. Already in 1970 Roll studied the distribution of the Treasury bill yield changes using the stability index, or Zolotarev- α_Z , and found that “With a large degree of confidence, most of the distributions of interest rate changes have α significantly lower than 2 and are thus non-Gaussian. Indeed, the upper limit of the simulation range suggests that most of the α -s are significantly lower than 1.5” (Roll, 1970, p. 73). The GBM has a stability index equal to 2, or, what is the same, a Hurst exponent equal to the Fickian value of 0.5. Thus, the characterizing feature of the GBM is that it scales the instantaneous volatility of pricing processes according to $\tau^{0.5}$, the square root of the maturity or time horizon τ . This scaling characteristic can greatly affect actual derivatives prices when the underlying asset prices do not adhere to such particular time-frequency scaling (e.g., Jamdee and Los, 2007).

Following Engle's (1982) Auto-Regressive Conditional Heteroskedasticity or ARCH model, Bollerslev (1986) proposed the Generalized ARCH or GARCH model to explain the empirically observed time-varying volatility of financial market pricing processes, driven by i.i.d. information processes. But the users of the GARCH model experience serious difficulties with the identification of its proper lag orders. Practically, the GARCH(1, 1) model is now very common in financial time series modeling, but that is mainly due to its overreaching simplicity. Although it captures skewness and kurtosis phenomena in addition to time-varying volatility, the GARCH model does not identify other important phenomena of empirical financial data, such as time-frequency scaling and long-range dependence, or "Long Memory".

With the objective to mitigate some of the drawbacks of both the GBM and GARCH(1, 1) models, this paper uses the Multifractal Model of Asset Return (MMAR) of Calvet, Fisher and Mandelbrot (1997) as a viable and empirically satisfying substitute to model each of the eight nodal interest rates of the Japanese term structure. In our approach, each of the nodal interest rates is modeled as a multifractal Brownian motion, driven by a multifractal information process instead of by an i.i.d./Wiener–Gauss information process.

In fact, this paper implements the MMAR for the first time as the diffusion process of the Japanese Treasury monthly interest rate series for various maturities and compares its performance with that of the affine GBM and GARCH models. Monte Carlo simulations are used for model performance measurement, in the sense that the identified models are required to reproduce the identified characteristics of the empirical Japanese interest rate series. It should be recognized that this paper does not attempt to price any Japanese bonds. Rather, the paper focuses on the analysis of simulated fractal price diffusion processes of the nodal market interest rates of the Japanese term structure. The identified dynamic term structure of interest rate processes can then be used to price bonds, via the conventional bond pricing formulas.

Based on monthly data made available to us by the Capital Markets Function of the Federal Reserve Bank of New York, the main finding of this paper is that the Japanese interest rate series from the 6-month to 20-year maturities show mild anti-persistence overall, with the exception of the 20-year maturity interest rate, which shows severe anti-persistence in the range of possible chaos. This happens despite the fact that some of the trading clustering can be shown to be persistent. This finding surprised us and therefore will lead to more research in the future with higher frequency data, which are not yet available for these Japanese interest rate series. In addition, our simulations of the empirically identified models suggest that the MMAR might not always be superior to the GBM and GARCH(1, 1) processes in modeling the time-scaling characteristics of the Japanese monthly

interest rate series, because it experience difficulties with reproducing the proper degree of anti-persistence.

The paper is organized as follows. Section 2 reviews the literature about interest modeling based on GBM and GARCH processes and enumerates their salient drawbacks, which we try to overcome. Section 3 presents the empirical Japanese monthly data. Section 4 explains the MMAR methodology used. It discusses how to detect multifractality, how to identify the crucial parameters of the return series, how to reconstruct the series using the identified parameters, how to simulate the return process, how to measure the model's overall performance, and how to analyze the higher moments of the simulated results. Section 5 presents the empirical results and Section 6 provides a summary and some conclusions.

2. LITERATURE REVIEW

The very first dynamic interest rate model, a one-factor affine model, was introduced by Vasicek (1977). Other popular affine dynamic models include the two-factor model of Longstaff and Schwartz (1992) and the one-factor model of Hull and White (1993). In particular, the two-factor model followed the introduction of the extended Vasicek and extended Cox, Ingersöll, and Ross (CIR) one-factor affine models. The one-factor model can only explain parallel (up-and-down) shifts of the term structure of interest rates. The two-factor model can explain both its parallel and slope shifts. The three-factor model can explain its parallel level, slope and curvature changes. Higher-order dynamic models can explain an even greater variety of dynamic movements of the term structure of interest rates.

For example, the new generation of three-factor affine models, was proposed by Balduzzi, Das and Sundaram (1996). Based on the principal components analysis of the covariance matrix of interest rates, Brandt and Kavajecz (2004) suggest that more than one, but not many more than three factors, can sufficiently capture the parallel and slope and curvature changes of the term structure, i.e., more than 90% of the term structure variation.

Besides assuming the GBM as the underlying interest rate diffusion process, some researchers have tried to use the GARCH model as the dynamic process, e.g., Longstaff and Schwartz (1992). The following sections review the drawbacks of the affine GBM and GARCH(1, 1) processes, which prodded us to try and find a better stochastic process for dynamic interest rate modeling.

2.1. Limitation of the Affine Dynamic Models

Los (1989, 2003) and Rebonato and Cooper (1996) argue that the statistical pitfalls of the principal component analysis to identify the factors for the models

create a serious model identification problem. The percentage of variation attributable to a particular component depends on the number of components prejudicially retained from the computed covariance matrix. Thus, both the size of the covariance matrix, or the number of the term structure's maturity segments, as well as how many of these segments are considered significant, are crucial subjective modeling choices since these choices determine the percentages of the variation decomposition. In fact, this problem is inherent to all more-than-one-factor affine models.

We mentioned that the one-factor Vasicek model only allows for parallel shifts of the term structure Schlögl and Sommer (1998). In addition, Bakshi and Chen (1996) and Rogers (1996) comment that with its assumed Gaussian distribution, the model can also erroneously produce negative interest rates. Cox, Ingersoll and Ross (1985) already solved this problem by incorporating a reflecting boundary for the diffusion process. The resulting pricing process remains the same (an exponentially affine pricing process) after their adjustment, although the new bond prices (= horizon dependent deterministic functions) are quite different.

Schlögl and Sommer (1998) also argue that while the two-factor models allow for the level and slope changes of the term structure, they still do not generate the correct third and higher order dynamic distribution moments. Kappi (1997) uses maximum likelihood estimation (which can be shown to be equivalent to the scientifically deficient principal components analysis, cf. Los, 1989, 2001) to estimate the two-factor models and found that they can identify the level and the slope changes, but, unsurprisingly, cannot identify the curvature of the term structure. With one additional factor to explain the curvature, the three-factor models perform better than the two-factor models. However, Los (1989) and Brandt and Kavajecz (2004) clearly show that the three factors of those three-factor models cannot be uniquely identified, even though modelers erroneously think of them as *the* level, slope, and curvature of the term structure.

While Duffie and Kan (1994) and Dai and Singleton (2000) correctly state that a price process, that is exponentially linear in the short rate price process with drift and variance components in the one or two factors, is a general class of affine models, these simple features are thus incompatible with the empirical evidence and do not correctly identify the time-varying distributional structure of the term structure's rates. Johannes (2004) has recently tested both nonparametric one-factor models and the two- and three-factor models of Andersen and Lund (1997, 1998). The results indicate that none of these models are able to capture the ARCH and non-Gaussian long-term dependence ("scaling") features of the empirical data. Johannes (2004) argues that a multi-factor model might be able to match the nonlinearity of the observed data by grossly increasing the volatility in

the model. However, the cost of the modification is so severe that the simulated interest rate path becomes completely irregular.

Thus the simple affine models fail correct empirical model identification by the simple fact that the information structure of the model is generated by connecting a simple affine (= “linear”) structure and a (Fickian) GBM information process, that does not allow any singularities or exceptional, unpredictable surprises, intermittence and clustering, i.e., the features that are empirically found in the time series generated by the financial markets.

2.2. GARCH Process Models

Bollerslev (1986) introduced the GARCH (p, q) process, generalizing the 2003 Nobel Memorial Prize winning ARCH process of Engle (1982). The GARCH (p, q) process has been found to be very useful in modeling the time-varying volatility of underlying assets, i.e., their rates are non-stationary in the weak sense. This model is now widely accepted by academicians and practitioners.

Although GARCH can be used in any higher order of moving average and autoregressive models, in practice only GARCH(1, 1) is widely used, because the parameters of higher-order GARCH models are very difficult to uniquely identify and often have to be subjectively calibrated, defeating the scientific intent of GARCH modeling. Andersen and Lund (1997), Dai and Singleton (2000) use GARCH to approximate the density of short-rate series and then estimate their underlying processes. Without pricing any interest rate options, Brenner, Harjes and Kroner (1996) suggest that GARCH model can capture stochastic volatility and varying serial correlation of the short-rate, the 3-month Treasury bill, series.

Dai and Singleton (2000) also use GARCH to capture the underlying process of the short rate in their two-factor model, but later find that their model inadequately reproduces empirical reality. Fisher, Calvet and Mandelbrot (1997) argue that the finite memory of the discrete time GARCH process prevents it from replicating the long memory time-and-frequency scaling patterns found in empirical financial market data.

Combining a multi-factor interest rate models with a GARCH information process to capture either the short-term interest rate process or its volatilities, Bali (2003), Heston and Nandi (2003), and Saltoglu (2003) show that GARCH helps improve the predictability of multi-factor models, although Saltoglu (2003) reports that the GARCH model is slightly outperformed by other nonlinear and nonparametric methods such as Artificial Neural Networks and kernel smoothing.

The limitations of the GARCH model, such as its unidentifiable lag orders and its finite short term memory, urge us to find a better identifiable model. One of the

currently most promising models is the MMAR of Calvet, Fisher and Mandelbrot (1997).

2.3. Multifractality Modeling

The MMAR is the third generation of price diffusion models, following the multifractal financial market information theory of Mandelbrot (Mandelbrot and Hudson, 2004). This model is based on the compounding of a (Fickian) GBM interest rate pricing process with a persistent multifractal, market news, information process. This compounded multifractal diffusion model produces a multifractal interest rate process with a proper persistence level to match that of empirically observed interest rate processes.

The fractal scaling property is one of the main key components that generate thick-tail and long-term dependence phenomena in time series, as explained by Mandelbrot (2001a, 2001b, 2001c, 2001d). Mandelbrot argues that both phenomena are common in nature (Mandelbrot, 1982). Moreover, the MMAR produces a martingale, or no-arbitrage, pricing process, in contrast to the monofractal Fractional Brownian Motion (FBM), which does not produce a martingale and allows for a limited form of arbitrage, as proved by Rogers (1997).

Since the MMAR is partly based on the monofractal FBM, identification of the global degree of persistence of the financial time series is required. Table 12.1 provides a summary of recent published measurements of such global degrees of persistence of financial market time series. There are two salient observations in this table 12.1. First, none of the published measurements include option markets. Second, most reports appeared only in 2004 and thereafter. This avalanche of very recent publications suggests that the topic is only very recently gaining interest in the financial community and there still remain important gaps in the published empirical research. This paper is one of such efforts to fill the gaps.

Calvet and Fisher (2002) state that the MMAR is a hybrid between jump diffusion models and the GBM, such that the MMAR contains all necessary characteristics found in the observed empirical data. Table 12.2 adapted from Mandelbrot, Fisher and Calvet (1997) and Calvet and Fisher (2002) suggests that the MMAR is superior to other time series models in the empirical and theoretical aspects needed for the dynamic modeling of financial time series: long memory, time-and-frequency scale consistency, volatility clustering with no-arbitrage, martingale pricing.

Beside the MMAR, only the Fractional Integrated GARCH (or FIGARCH) and GARCH models can exhibit the empirically observed volatility clustering in return series, while preserving the theoretical no-arbitrage martingale property or One-Price-Law. The monofractal FBM, ARFIMA, and ARMA models all exhibit

Table 12.1

Studies of Long Memory Published in "A" Level Finance Journals since 1994. Source: Jamdee and Los (2007).

Author	Year	Hurst Exponents				
		Stock	Term Structure	Futures	Cash	Forex
Karuppiah and Los	2005					X
Di Matteo et al.	2005	X	X			X
Gil-Alana	2004				X	
Lillo and Farmer	2004	X				
McCarthy et al.	2004		X			
Morana and Beltratti	2004					X
Mulligan	2004	X				
Mulligan and Lombardo	2004	X				
Corazza and Malliaris	2002			X		X
Henry and Olekalns	2002					X
Cheung and Lai	2001					X
Lee et al.	2001	X				
Crato and Ray	2000			X		
Grau-Carles	2000	X				
Lien and Tse	1999	X		X		
Opong et al.	1999	X				
Hauser	1998				X	
Barkoulas and Baum	1998	X	X			X
Barkoulas et al.	1997				X	
Jacobsen	1996	X				
Cheung and Lai	1995	X				
Evertsz	1995a, 1995b	X				X
Evertsz and Berkner	1995	X				

correlation in the return series without this martingale property. Therefore these non-martingale models all provide arbitrage opportunities and don't adhere to the theoretical no-arbitrage requirement. Also, the MMAR as a continuous time model has an advantage over its discrete GARCH-type model candidates, because it can be used with very high frequency (e.g., tick-by-tick) data.

3. MONTHLY JAPANESE INTEREST RATE DATA

The empirical monthly Japanese Treasury interest rate series are provided to us by the Capital Markets Function of the Federal Reserve Bank of New York, which obtained them from the Bank of Japan. They are available upon request. No higher frequency of Japanese interest rate series is currently made available to academic

Table 12.2

The Comparison between MMAR and Other Time Series Models. Sources: Mandelbrot, Fisher and Calvet (1997) and Calvet and Fisher (2002)

Dynamic Volatility Models		Properties
Martingale Pricing	Arbitrage Opportunities	
MMAR	FBM	Long Memory
FIGARCH	ARFIMA	Scale Consistency
GARCH	ARMA	Long Memory
		Scale Consistency
		Short Memory
		Scale Inconsistency

researchers. This paper uses the monthly computational interest rate series with 6-month, 2-year, 3-year, 4-year, 5-year, 6-year, 10-year, and 20-year maturities.

The interest series in this study cover the period of January 1987–August 1997. This approximate 11-year period provides only 128 monthly observations, severely hampering the achievable accuracy of the model identification. This length of the data set is necessarily chosen such that it follows Los's (2003) suggestion about business cycles that last approximately 10 to 12 years. Each interest rate series for any maturity has the same number of observations. The same length of period is used to compute the partition function (sample sum), scaling function, Legendre multifractal spectrum, and monofractal Hurst exponent as explained in the next section.

4. MMAR: DETECTION, IDENTIFICATION, SYNTHESIS AND SIMULATION

The purpose of this paper is to identify the diffusion processes of the eight nodal interest rate series of the Japanese Treasury term structure and, possibly, their coherent system. Only the first five dynamic moments of the eight simulated interest rate paths are thoroughly analyzed: mean, variance, skewness and kurtosis.

The Multifractal Model of Asset Returns (MMAR) was initially proposed by Calvet, Fisher and Mandelbrot (1997), Fisher, Calvet and Mandelbrot (1997), Mandelbrot, Fisher and Calvet (1997) and Calvet and Fisher (2002) and empirically tested with foreign exchange rates, the U.S. stock index, and individual U.S. stocks. In addition, Fillol (2003) has successfully applied the MMAR to the French Stock Index.

Unlike McCarthy et al. (2004) who use the Haar Wavelet to measure the degree of persistence by identifying the *monofractal* Hurst exponents of the U.S. Treasury rate series of all nodal maturities, this paper examines the *multifractal* processes of the various Japanese Treasury rate series, identifies each of their multifractal spectra and the parameters of their corresponding MMARs using the Morlet(6) wavelet, and compares the performances of these MMARs with their respective GBM and GARCH(1, 1) processes. The procedure of MMARs consists of (1) identifying the multifractal spectra of the time series of the nodal interest rates of the term structure, (2) computing the values of their parsimonious parameters, (3) synthesizing the multiplicative probability measures that preserve their identified multifractality properties, and (4) simulating the compounded processes of the pricing GBMs driven by the identified multifractal trading time information processes.

The MMAR is a stochastic rate process $X(t)$, such that

$$X(t) = \ln P(t) - \ln P(0) \quad (1)$$

where $P(t)$, $0 \leq t \leq T$, is the original price series, and t represents the conventional clock time. Thus, $\{X(t)\}$ is a multifractal process that has the following modeling properties:

ASSUMPTION 1. $X(t)$ is a compounded process, where a Brownian Motion operates on a multifractal trading time function:

$$X(t) \equiv B_H[\theta(t)] \quad (2)$$

where $B_H[\cdot]$ is an FBM with Hurst exponent H so that $0 < H < 1$, and with trading time $\theta(t)$. The trading time process $\theta(t)$ deforms or “warps” the multifractal, clustering market information process in conventional clock time t into equally-distanced trading time θ , on which the conventional GBM $B[\cdot]$ operates.

ASSUMPTION 2. Trading time $\theta(t)$ is the cumulative distribution function (c.d.f.) of a multifractal measure defined on the time axis $[0, T]$. It reflects the actual market news dissemination or information process that affects the volume of trades on the trading floors. It changes the unequally-spaced, or clustering trading events into equally-distanced fractal trading events, that form the multifractal information process driving the GBM pricing process.

ASSUMPTION 3. The return generating pricing process $B[\cdot]$ and the multifractal information process, or trading time function $\theta(t)$ operate independently of each

other. In other words, although the interest rate markets are driven by the trading events, their pricing operation, established by market arbitrage, is mechanically independent of them.

One can transform a monoscaling process like the monofractal Brownian motion into a multiscaling process by properly mapping the one dimensional time domain $t \rightarrow \theta(t)$ where the trading time possesses all the multifractal properties that are expected to be passed on directly to the pricing FBM. The Hurst exponent of the second moment of the final interest rate process $B_H[\cdot]$ is then about (but not quite!) the “average” of the (second moment) neutral Hurst exponent ($H = 0.5$) of the standard GBM and the persistent (second moment) Hurst exponent ($0.5 < H < 1$) of the information process. It is not exactly the same, since the information process is not monofractal but multifractal and shows an asymmetrical spectrum with dispersion (width) and skewness. The monofractal Hurst exponent of that multifractal information spectrum is actually the relatively most frequent Lipschitz- α of that asymmetrical spectrum, characterizing the residual “randomness” of the interest rate series.

The model identification of the MMARs begins with the identification of the Hurst exponent of the empirical interest rate process $B_H[\cdot]$, from which the Hurst exponent of the information process or trading time $\theta(t)$ is then inferred, based on the fitted, second-order polynomial shape of the multifractal information spectrum.

4.1. Identification of Scaling Properties and Multifractal Spectra

The detection of the multifractality of the interest rates begins with the computation of the multi- q -order distributional moments of Gibbs’ partition function

$$S_\delta(T, q) = \sum_{i=1}^n |X_{\lceil i \cdot \delta \rceil} - X_{\lceil (i-1) \cdot \delta \rceil}|^q \quad (3)$$

where $\lceil \cdot \rceil$ is the integer part operator, and δ is the time increment. By the definition of multifractality, a stochastic process $X(t)$ is multifractal if it has stationary increments and satisfies the fractional moment relationship

$$E\{|X(t)|^q\} = c(q)t^{\tau(q)+1} \quad (4)$$

for all $t \in B$, $q \in Q$, where $E\{\cdot\}$ is the expectation operator and $c(q)$ is called the moment’s prefactor. B and Q are positive real numbers where $0 \in B$ and $[0, 1] \subseteq Q$. In other words, the distributional moments of the process $X(t)$ are clearly

scaled with the *scaling exponent* $\tau(q)$. The moment order, q , can theoretically be negative. According to Mandelbrot, Fisher and Calvet (1997) negative moments do not occur in empirical financial data, but others (Los and Yalamova, 2006) found differently for some empirical stock market prices immediately after stock market crashes, when the “randomness” of the after-shock stock market pricing process is exceptionally high.

By logarithmic transformation, the partition function can be rewritten as

$$\log(S_\delta(T, q)) \approx \tau(q) \log(\delta) + \log[c(q)] + \log(T). \quad (5)$$

Clearly, this equation is an approximately affine (“linear”) relationship. This equation also implies that if any function has scaling properties, the logarithmic plot of the partition functions against the time increment should be an approximately straight line. With various moments, q , and incremental time, δ , one can identify the scaling function, $\hat{\tau}(q)$, using various simple projection methods. Then, using the Legendre transform on the identified scaling function $\hat{\tau}(q)$ one can identify the multifractal spectrum $\hat{f}(\alpha)$ from this scaling function as

$$\hat{f}(\alpha) = \min_q [q\alpha_L - \hat{\tau}(q)] \quad (6)$$

where α_L is a localized Hurst exponent, or (using a more precise definition!) a Lipschitz- α_L .

4.2. Identified Hurst Exponents and Parameters of the Cascading Measures

Given that interest rate series shows such time-frequency scaling, Mandelbrot, Fisher and Calvet (1997) and Calvet and Fisher (2002) have proved that the following identities hold:

$$\hat{\tau}_X\left(\frac{1}{H}\right) = \tau_\theta(1) = 0, \quad (7)$$

$$\tau_X(q) = \tau_P(q) = \tau_\theta(Hq), \quad (8)$$

$$f_X(\alpha_L) = f_P(\alpha_L) = f_\theta\left(\frac{\alpha_L}{H}\right). \quad (9)$$

The first identity allows the identification of the Hurst exponent $\hat{H}$ of the log price series. This identification can be executed by finding the partition function plot at a particular moment q that is approximately parallel to the horizontal axis. In other words, the partition function plot of a particular q and δ that has a zero

slope can be used to solve backward for the monofractal Hurst Exponent of the interest rate process $B_H[\cdot]$.

The second identity shows that both the return and price processes, $X(t)$ and $P(t)$, respectively, have the same scaling function, while the scaling function of the trading time has the same shape, but is shifted by the factor Hq .

The third identity shows that the multifractal spectra of the processes $X(t)$ and $P(t)$, each computed by using the Legendre transformation of the scaling function, are the same. Again, the multifractal spectrum of the trading time has the same shape, but is shifted by a factor of $\frac{\alpha_L}{H}$. This last identity is very important for constructing the MMAR and will be used in next section.

4.3. Synthesizing the Lognormal Measures

Multiplicatively cascading probability measures form the key for reconstructing and simulating the MMAR from the identified model parameters. They have all ideal scaling properties that will be transferred to the simulated FBM, exhibiting the empirically identified long-term dependence, when the two processes are compounded. The cascading probability measures are normally used to generate positive multifractality, using iteration techniques. The value of the multiplicative measure, μ_{k,b_k} built on a single mass M_0^0 , after k iterations at interval B_k , is given by

$$\mu_{k,b_k} = M_{b_k}^k \cdot M_{b_{k-1}}^{k-1} \cdots M_{b_1}^1 \cdot M_0^0 \quad (10)$$

for any dyadic (= by a factor of 2) partitioning of the intervals. The initial probability mass M_0^0 is “divided” up by multiplying by a cascade of probability measures to result in a final empirically realistic distributional measure μ_{k,b_k} .

There are several extensions of these multiplicatively cascading probability measures. One can introduce stochastic probability measures by using any known distribution, e.g., the Gaussian distribution. Empirically, one can ascertain, by examining their multifractal spectra, that most financial time series, including interest rates, exhibit multifractal spectra with humped shapes, while their trading time is the cumulative distribution function (c.d.f.) of multiplicative random probability measures with simple lognormal masses (cf. Baillie, Bollerslev and Mikkelsen, 1996; Bollerslev, 1986; Calvet, Fisher and Mandelbrot, 1997; Calvet and Fisher, 2002; Mandelbrot, Fisher and Calvet, 1997).

Calvet, Fisher and Mandelbrot (1997) prove that the multifractal spectrum function of trading time θ with lognormally distributed masses is given by the formula

$$f_\theta(\alpha_L) = 1 - \frac{(\alpha_L - \lambda)^2}{4(\lambda - 1)} \quad (11)$$

where f_θ is hump-shaped and symmetric around its maximum or most probable Hurst exponent, $\hat{\alpha}_{L0} = \lambda$.¹ The first two moments of the lognormal distribution are as follows:

$$\hat{\lambda} = \frac{\hat{\alpha}_{L0}}{H} \quad \text{and} \quad (12)$$

$$\hat{\sigma}^2 = \frac{2(\hat{\lambda} - 1)}{\log b} \quad (13)$$

where $b = 2$ (dyadic). With the identified mean $\hat{\lambda}$ and variance $\hat{\sigma}^2$, the multiplicative lognormal probability measure path can be synthesized for a length of 2^K , which should be greater than the desired length of simulated interest rate series. For each step of the construction of the multifractal lognormal probability measure path, we draw the masses M , where $-\log_b M \sim N(\hat{\lambda}, \hat{\sigma}^2)$.

According to the MMAR architecture, the key parameter is the mean $\hat{\lambda}$. There are two methods that can be used to identify $\hat{\lambda}$. The first method uses the relation $\hat{\lambda} = \frac{\hat{\alpha}_{L0}}{H}$ and obtains the first moment $\hat{\lambda}$ directly from the multifractal spectrum of the log price process $f_X(\alpha_L)$ (Fillol, 2003). Calvet and Fisher (2002) propose a second method by fitting the multifractal return $f_X(\alpha_L)$ for the $\hat{\lambda}$. Let the relatively most frequent local Lipschitz- α_L be $\hat{\alpha}_{L0} = \lambda H$, then the log-price series $X(t)$ has the following quadratic multifractal spectrum:

$$f_X(\alpha_L) = 1 - \frac{(\alpha_L - \hat{\alpha}_{L0})^2}{4H(\alpha_{L0} - H)}. \quad (14)$$

Thus, if the monofractal Hurst exponent H is identified, the only free parameter α_{L0} can be obtained by a simple nonlinear fitting process. The identified $\hat{\alpha}_{L0}$ then leads to the calculation of $\hat{\lambda}$ and $\hat{\sigma}^2$ using Eqs. (12) and (13). After a proper synthesis of the multiplicative lognormal probability measure path, the next step is to compute the c.d.f. of the synthesized measures. The resulting time function is then the trading time $\theta(t)$.

4.4. Simulation of the MMAR

The simulation of each MMAR is conducted by compounding an FBM $B_H[\cdot]$ with the corresponding trading time $\theta(t)$. Calvet and Fisher (2002) and Fillol (2003) obtain a simulated FBM by computing the cumulative sum of the simulated Fractional Gaussian Noise (FGN) with respect to the identified mono-fractal

¹ See proof in Calvet, Fisher and Mandelbrot (1997).

Hurst exponent $\hat{H}$. The authors do not explicitly describe the particular simulation algorithm and interpolation of the FBM process and the MMAR used in their studies. Nevertheless, the overall scheme of the MMAR construction can be found to be as follows.

A finite-stage synthesis of a multifractal probability measure is obtained following the steps described in the preceding section. The length of synthesized measure path must be corresponding with the desired length of the MMAR. For example, under the dyadic base of 2, if a simulated MMAR of length T is required, the length of measures will have a minimum integer number of stages k such that $2^k \geq T$. At each stage k , independent log-normal multipliers, or masses M , that have a distribution with the respective identified mean $\hat{\lambda}$ and variance $\hat{\sigma}^2$, are randomly drawn. Once all k stages are finished, the cumulative sum of the measures provides the accumulated trading time $\theta(t)$.

A discretized path of an FBM $B_H[\cdot]$ in this study is generated by simulating the first differences of the FBM $B_H(t) - B_H(t - 1)$, which is the FGN with parameter H . The autocovariance function (ACF) of the FGN follows:

$$\gamma(k) = \text{Cov}[B_H(t) - B_H(t - 1), B_H(t + k) - B_H(t + k - 1)] \quad (15)$$

$$= \frac{\sigma^2}{2} (|k + 1|^{2H} - 2|k|^{2H} + |k - 1|^{2H}). \quad (16)$$

With $0.5 < H < 1$, the interest rate process is persistent, with $0 < H < 0.5$ the process is anti-persistent and with $H = 0.5$, the process is neutral and we have the conventional ACF of the white noise process:

$$\gamma(k) = \frac{\sigma^2}{2}. \quad (17)$$

Thus, one can simulate either the FBM $B_H[\cdot]$ directly, or the FGN and compute its cumulative sum to obtain the FBM. The simulated FBM then can be compounded with the previously computed trading time $\theta(t)$.

5. EMPIRICAL RESULTS

Our empirical analysis begins with the time series plot of the Japanese Treasury term structure across its eight nodal maturities as in Figure 12.1. This plot suggests various shapes of the Japanese term structure over time. For most of the time period, the Japanese term structure exhibits an upward-slope, where in the picture the band of the plots is wide. The term structure shows a much less significant

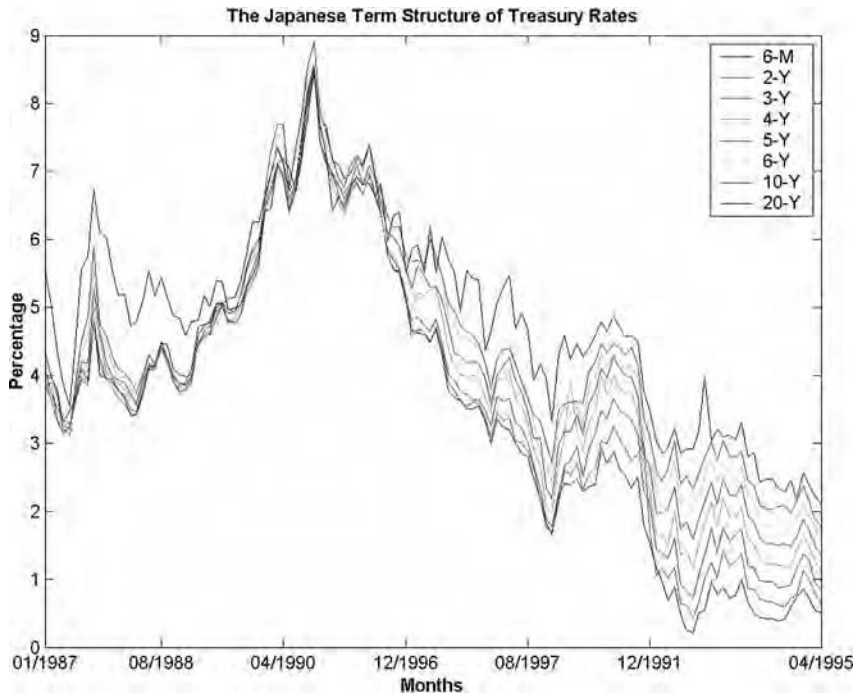


Fig. 12.1. The Term Structure of Constant Maturity Japanese Treasury Rates. The Japanese Treasury rates for eight maturities are plotted over time beginning from January, 1987 to August, 1997. For example, when the 10-year line is above the 3-month line, the term structure is upward-sloping. Vice versa, it is downward sloping

slope and possibly flattens out from the third quarter of 1988 to the end of year 1995. A flat slope with a potential of a humped shape of the term structure—when some of the interest rates of the medium maturities are above both the very short and the very long interest rates—can be observed in the period between the years 1990 and 1993.

Figure 12.2 plots the logarithmic first differences of all eight return series with their identified monofractal price Hurst exponents H and trading time Hurst exponents α_{L0} . Notice that all the pricing Hurst exponents indicate anti-persistence in the interest rate series, while only three of the eight trading time Hurst exponents are anti-persistent. Also, in contrast to the US term structure, the Japanese term structure consists clearly of three very different trading regimes: (1) the 6-month, 2-, 3- and 4-year maturity markets show the highest persistence levels, mostly because of persistent (trendwise + unexpectedly shocking) market news

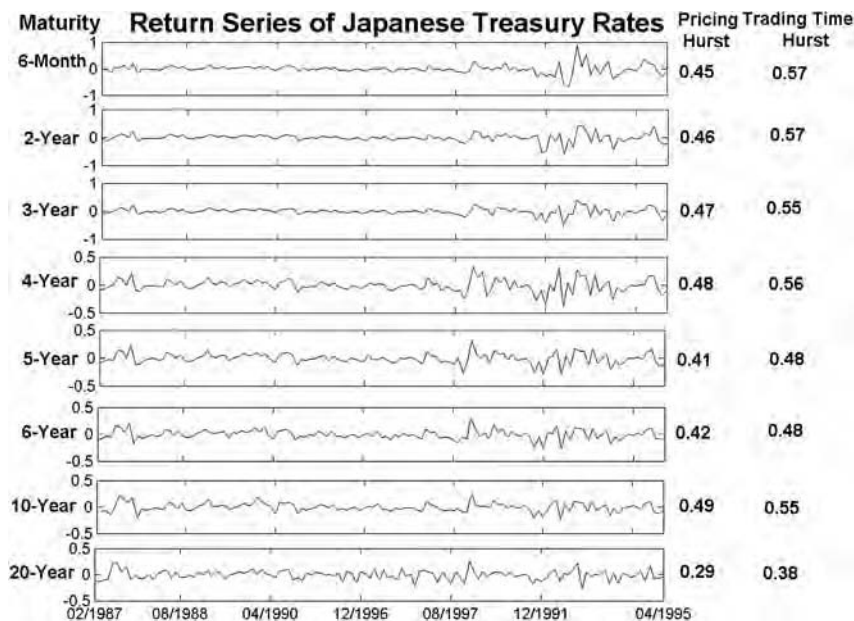


Fig. 12.2. The Time Series Plot of Individual Return Series of the Japanese Treasury (First Differences of the Logarithm of the Original Series). The left column indicates the maturity for each plot starting from the shortest, 6-month, to the longest, 20-year maturity, rates. The right two columns next to the plots provide the degree of persistence or monofractal Hurst Exponent identified by the Power Spectrum (Slope of Power Spectrum) method for each return series across studied maturities and for its corresponding trading time, respectively

information processes, although the market pricing processes are anti-persistent, i.e., faster than neutral mean-reverting, thus within a month; (2) the 5- and 6-year information processes show the same almost neutral market news information processes, still with anti-persistent, i.e., fast mean-reverting pricing processes; and (3) the 10-year information process is again as persistent as the 6-month, 2-, 3- and 4-year information processes, but with an almost neutral pricing process (i.e., akin that of the theoretical GBM).

However, the 20-year Japanese interest rate process is exceptional, since it shows a very anti-persistent information process, with very fast reversals, and with an even more anti-persistent pricing process, that is so rapidly reversing itself that it is almost in the chaotic range with a Hurst exponent $H = 0.29$ close to that of the observed anti-persistence level of an anchor currency like the Yen/Dollar exchange rate (Karupiah and Los, 2005).

The 10-year maturity Treasury rate series explicitly shows the almost neutral ($H = 0.49$) mean reversion over the studied period, i.e., on average reverting to the mean once a month, and does not show obvious singularities (or jumps). This behavior is similar to that of a standard GBM. The other plots also reveal a rather impressive picture of the singularities or jumps and heteroskedastic volatility clustering (= “intermittence”) in short maturity Treasury interest rate series, e.g., the time series plot of the 6-month return series since the end of 1991.

5.1. Time-Scale Analyses of Empirical Treasury Rates

The time-scale analysis begins with the 10-year maturity Treasury rate series. Figure 12.3 provides the analytical profile of the 10-year Treasury rates including in panel (a) the rebased partition function $S_q(T, \delta)$; in panel (b) the scaling function $\tau(q)$; in panel (c) the multifractal spectrum $f(\alpha_L)$; and in panel (d) the quadratic fitting of the multifractal spectrum. Panel (a) in Figure 12.3 exhibits the partition functions $S_q(T, \delta)$, plotted against the base-2 logarithm of investment horizon $\log_2 \delta$, covering the first five integer moments of the distributions, including the zeroth moment. Although this type of time-scale analysis allows also investigation of fractional moments, this paper focuses on the first four integer moments common in the financial literature. From the bottom up, in panel (a) the plot starts from the zeroth moment $q = 0$ (the lowest line) with a unit increment and ends at the fifth moment $q = 5$ (the highest line). The nearly straight partition function plots suggests that a particular scaling of moments exists and can be identified.

Notice that the partition functions of the first three moments are nearly straight with some increasing variation when the investment horizon (δ) becomes longer. The increasing variation of the computed higher-order moments affects the accuracy of the analysis and the identification of the MMAR parameters. It also suggests that the moment range of the observed scaling is rather limited: the 5th and 6th moments of the 10-year are clearly problematic, in the sense that they may not exist. To sustain sufficient identification accuracy this study uses $2^5 = 32$ months or two and a half years investment horizons to obtain the MMAR parameters for all nodal market maturities unless otherwise stated.

Panel (b) provides the scaling function $\tau(q)$ plotted against the first five moments, $q = 1, 2, 3, 4$ and 5. The scaling function is obtained from the slopes of the partition functions in panel (a). The 10-year series scaling function is concave upward. It deviates from the straight line with the global anti-persistent $H = \frac{[1-(-1)]}{5} = \frac{2}{5} = 0.4$ slope. Evidently, when the moments are less than 2, the scaling function of the 10-year rate is slightly higher than that of the anti-persistent $H = 0.4$. When the moments are larger than 2, the scaling function is somewhat lower than that of the anti-persistent $H = 0.4$. The almost neutral

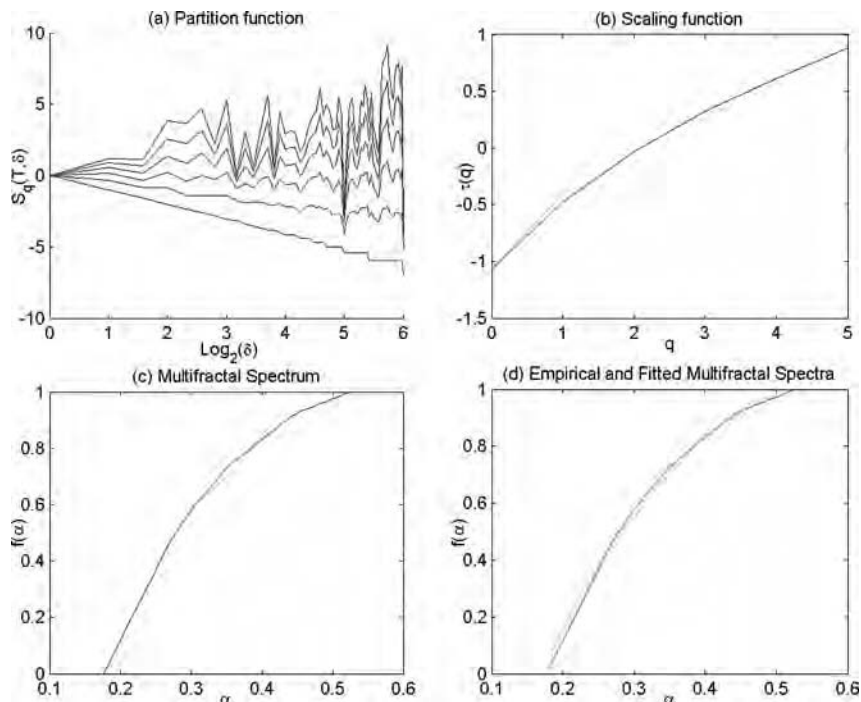


Fig. 12.3. The Time-Scale Analytical Profile of 10-Year US Treasury Rate: January 1987–August 1997. Panel (a) shows the partition function plots for the first five integer moments including the zero moment. The function intercepts are normalized for comparison. The highest line is for the fifth moment while the lowest line is for the zeroth moment. Panel (b) shows the scaling function plot of the Treasury rate across the five moments. Panel (c) provides the Multifractal Spectrum obtained from the Legendre transformation of the scaling function. Panel (d) shows that the Multifractal spectrum can be fitted by the quadratic function that leads to the detection of the MMAR's parameters

Hurst exponent of 0.49 is directly obtained from the scaling function using the relationship shown in the previous section, indicating the almost GBM character of the 10-year series. But the concavity of the 10-year scaling function $\tau(q)$ clearly demonstrates that there exists multifractal scaling of the moments of the 10-year interest rate series and, thus, the 10-year series is not exactly a GBM!

Panel (c) shows the quadratic-like multifractal spectrum, $f(\alpha_L)$ of the 10-year interest rate series obtained from the Legendre transformation of its scaling function $\tau(q)$. The multifractal spectrum is simply the entire distribution of the local Lipschitz- α 's of the 10-year interest rate series with a humped shape and a maximum of unity by convention. A complete, parabola-like multifractal spectrum

containing also the possible negative slopes can be obtained using a different method (Los, 2003).

Since the quadratic multifractal spectrum of the interest rates also implies the quadratic multifractal spectrum of its trading time, panel (d) assures us that the multifractal spectrum $f(\alpha_L)$ of the 10-year Treasury rate is almost perfectly quadratic. The fitted parabolic line lies almost exactly on top of the empirical multifractal spectrum. However, it slightly deviates when the Hurst exponents are less than 0.25, in the anti-persistent “chaos” range. Using the multifractal spectrum of the interest rate series and the closed form solution of the lognormally distributed multifractal spectrum of trading time in the preceding section, the relatively most frequent Hurst exponent of its trading time is calculated to be $\alpha_{L0} = 0.55$, which helps to identify the first two moments of lognormally distributed measures, which are $\hat{\lambda} = 1.13$ and $\hat{\sigma} = 0.27$, respectively. These two moments will be used later in the synthesis of measures and simulation of the MMARs

The results of other maturity Treasury term structure rates are quite similar. The primary difference is that greater increasing variation is found in the partition functions and that there are larger deviations between the fitting and empirical multifractal spectra in the chaotic ranges. Somewhat to our surprise, the other rate series show partition functions over a very limited range of moments, suggesting that their moments hardly scale, although they tend to do it with some globally identifiable anti-persistence ($H < 0.5$).

Table 12.3 provides all necessary MMAR parameters for each maturity. This is the collection of the time series models for each of the eight nodal interest rates in its simplest parametrization. Being able to handle the heteroskedasticity of the time series and preserving the correct scaling properties of the empirical data, the MMAR requires only four unambiguously identifiable parameters: the Hurst exponent H of the interest rate process, the most probable Hurst exponent of trading time α_{L0} , and the first two moments $\hat{\lambda}$ and $\hat{\sigma}^2$ of the lognormal distribution of the multiplicative probability measures. The list of MMAR’s parameters begins from those series with the shortest maturity, 6-month, to the longest maturity, 20-year rate.

Whatever persistence the Japanese interest rates possess is attributable to the highly persistent Hurst exponents α_{L0} of the multifractal trading time, i.e., the exogenous news information process. In other words, while the theoretical pricing process may be a theoretical, neutral GBM, the empirically observed (anti-)persistence of the process is caused by the clustering of the actual trading events, which is induced by the exogenous clustering of news events (Mandelbrot and Hudson, 2004). Thus the level of persistence of a market is not necessarily an anti-persistent success or a persistent failure of the efficiency of the pricing process. The arbitrage-free pricing of freely competing market participants

Table 12.3

The Parameters of Treasury Rate MMARs. Hurst (H) is the monofractal Hurst Exponent of the empirical interest rate process. Alpha zero is the most probable Hurst exponent of the trading time's multifractal spectrum. Mean and variance are the first two moments of the lognormally distributed multinomial measures, respectively.

Maturity	Pricing Hurst (H)	Trading Time Alpha Zero (α_0)	Mean ($\hat{\lambda}$)	Variance ($\hat{\sigma}^2$)
20-year	0.293	0.38	1.295	0.59
10-year	0.485	0.55	1.134	0.268
6-year	0.417	0.48	1.151	0.301
5-year	0.407	0.48	1.180	0.360
4-year	0.481	0.56	1.165	0.331
3-year	0.467	0.55	1.177	0.354
2-year	0.461	0.57	1.236	0.472
6-month	0.451	0.57	1.264	0.528

is showing various degrees of persistence mostly due to the various degrees of persistence (“clustering”) of the world news events, as reported by the media and what we model as the information process.

But one can wonder if this non-neutral (anti-)persistence phenomenon is related to the frequency of the respective Treasury auctions, or to the number of trading participants, or both. We know that a degree of persistence in this pricing system process, like the beat of a healthy human heart, is determined by the degrees of freedom of the process, but we still don't know how these two parameters are precisely related. This is an important potential market micro-structure research problem, since it holds the clue to re-organizing the institutional conditions of an inefficient or distorted market in such a fashion that it can be re-engineered from being an inefficient into an efficient market by market “open-heart surgery”.

The first moments of the lognormally distributed measures $\hat{\lambda}$ seem to show systematic characteristics, except the ones of the 20-year rate. The short maturity rates indicate higher $\hat{\lambda}$ values than those of longer maturity rates. Evidently $\hat{\lambda}$'s across maturities are larger than one, since the series of trading events show more clustering than the actual interest rate pricing. Notably, the maximum of the $\hat{\lambda}$'s is 1.295, which is for the 20-year rate series, suggesting that the 20-year market has the most tenuous relationship between the degree of persistence of its market pricing process and the degree of persistence of its information process.

Interestingly, the variances $\hat{\sigma}^2$ of those log normal probability measures seem to indicate a possible system for the multifractal spectra. The shorter maturity Treasury rates show a more dispersion, i.e., larger $\hat{\sigma}^2$'s, of their multifractal spectra than those of interest rates with the longer maturities, except for the 5- and 20-

Table 12.4

The Parameters of GARCH(1, 1). c is the coefficient of the constant term in mean equation. k is the coefficient of the constant term in the variance equation. a is the coefficient of the GARCH effect in the variance equation. b is the coefficient of the ARCH effect in the variance equation.

Maturity	c	k	a	b
20-year	0.0079	0.00260000	0.2963	0.1493
10-year	0.0061	0.00097787	0.1886	0.1742
6-year	0.0066	0.00046782	0.0764	0.0675
5-year	0.0076	0.00029200	0.052	0.0544
4-year	0.0074	0.00028821	0.0534	0.064
3-year	0.0070	0.00023109	0.0412	0.0454
2-year	0.0089	0.00026172	0.0361	0.0448
6-month	0.0075	0.00037810	0.0572	0.0704

year maturity rate series which are not in a decreasing order. This suggests that the shorter maturity markets in Japan are impacted by a wider variety of news events (including “rumors”) than the longer maturity markets, which are dominated by the focused analytic and optimizing portfolio management procedures of long term institutional investors.

Overall, all Japanese term structure interest rate series show anti-persistence and have a “negative” memory, except for the 10-year rate series which is very close to the neutral memory of the GBM. Moreover, the results seem to indicate the non-Gaussianity of the distributions of some series, the possible existence of nonlinearity, and time-and-frequency scaling properties in the Treasury series. Nevertheless, there also is also the observed non-existence of higher distributional moments for some interest rate series.

These findings provide challenging empirical evidence relative to the popular GBM driven low-factor models in the current term structure literature, which assume neutral Hurst exponents of $H = 0.5$. As a part of MMAR’s performance measurement particularly in the case of Japanese Treasury rate series relatively to those of GBM and GARCH(1, 1) processes, the parameters of the GARCH(1, 1) models for all studied Treasury rate series are collected in Table 12.4, while those of the GBM simply are the first two moments of the studied return series.

5.2. Comparative Analysis of Simulated Results

The performance of MMAR is first tested by investigating how effectively it can preserve the “negative” memory found in the empirical series. The monofractal Hurst exponent for each simulated MMAR is identified for each maturity. The

Table 12.5

Averaged Hurst Exponents of 1,000 Simulated MMARs. The average Hurst (MMAR) column provides the average of Hurst exponents from the 1,000 simulated MMARs for each maturity. The Input Hurst (Empirical) column shows the detected Hurst exponents from the empirical data for each maturity.

Maturity	Average Hurst (MMAR)	Input Hurst (Empirical)
20-year	0.46	0.29
10-year	0.43	0.49
6-year	0.44	0.42
5-year	0.43	0.41
4-year	0.44	0.48
3-year	0.46	0.47
2-year	0.46	0.46
6-month	0.46	0.45

resulting Hurst exponents are then averaged for each maturity and then reported in Table 12.5.

The average Hurst exponents for all Treasury maturities deviates from those Hurst exponents fed into the simulation algorithm, except the 2-year rate, where the average Hurst exponent is identical to the corresponding input. Notice that the average of the simulated MMARs of the long maturities rates has a quite different degree of anti-persistence than found in the empirical series. It is much more difficult to simulate anti-persistent time series than persistent time series, because the anti-persistent series mean-revert more than once within the observational time unit of one month. Although prior studies provide numerical support that the MMAR can effectively preserve the monofractal Hurst exponent for studied Treasury rate series across maturities, that was only for persistent time series. But, similar to the GBM and the GARCH(1, 1) models, the MMAR experiences difficulty with the simulation of anti-persistent time series.

Table 12.6 presents the identified scaling exponents or slopes of the partition functions for the first five integer moments of the empirical Treasury rates and the mean scaling exponents of those simulated MMAR, GBM, and GARCH(1, 1) series with the maturities longer than four years. Table 12.7 presents the scaling exponents for those Treasury series with the maturities less than five years. The mean scaling exponent of the simulated series is calculated by averaging those scaling exponents of the 1,000 simulated series for each process. The mean scaling exponents of the simulated GBM series for all maturities are quite similar. Their scaling exponents increase approximately by the same value for each moment order q across the maturities. Although the results are not surprising, they

Table 12.6

The Comparison between scaling exponents of Empirical Treasury Rates and Mean Scaling Exponents of Corresponding Simulated Processes. The results are for Treasury rates with more than 5-year maturities. The first left column under each maturity provides the scaling exponents for the first five integer moments. The next three columns provide the average scaling exponents from 1,000 simulations for the MMAR, GBM, and GARCH(1, 1) processes, respectively. The minimum and maximum values of the exponents are reported in parentheses. Emp. means 'Empirical' while Sim. means 'Simulated'.

Moment (q)	20-Year Mean $\tau(q)$				10-Year Mean $\tau(q)$			
	Emp. Series	Sim.		Sim. GARCH (1, 1)	Emp. Series	Sim.		Sim. GARCH (1, 1)
		MMAR Cholesky	Sim. GBM			MMAR Cholesky	Sim. GBM	
1	-0.67	-0.48	-0.57	-0.54	-0.48	-0.55	-0.56	-0.55
		[-1.01, -0.16]	[-1.25, -0.15]	[-1.16, -0.12]		[-0.1, -0.19]	[-1.19, -0.20]	[-1.22, -0.14]
2	-0.34	-0.11	-0.16	-0.11	-0.03	-0.18	-0.14	-0.16
		[-1.18, 0.37]	[-1.54, 0.61]	[-1.39, 0.68]		[-1.12, 0.57]	[-1.38, 0.54]	[-1.51, 0.65]
3	-0.09	0.14	0.19	0.25	0.36	0.09	0.21	0.15
		[-1.61, 0.93]	[-1.89, 1.36]	[-1.69, 1.42]		[-1.40, 1.27]	[-1.61, 1.28]	[-1.92, 1.36]
4	0.12	0.34	0.5	0.56	0.7	0.31	0.53	0.40
		[-2.09, 1.47]	[-2.28, 2.09]	[-2.04, 2.11]		[-1.76, 1.94]	[-1.94, 1.99]	[-2.39, 2.03]
5	0.3	0.51	0.79	0.85	1.01	0.49	0.82	0.63
		[-2.61, 1.98]	[-2.69, 2.80]	[-2.41, 2.78]		[-2.15, 2.57]	[-2.29, 2.68]	[-2.92, 2.67]

Moment (q)	6-Year Mean $\tau(q)$				5-Year Mean $\tau(q)$			
	Emp. Series	Sim.		Sim. GARCH (1, 1)	Emp. Series	Sim.		Sim. GARCH (1, 1)
		MMAR Cholesky	Sim. GBM			MMAR Cholesky	Sim. GBM	
1	-0.55	-0.51	-0.56	-0.56	-0.55	-0.50	-0.56	-0.56
		[-0.8, -0.24]	[-1.27, -0.16]	[-1.04, -0.22]		[-0.83, -0.25]	[-1.17, -0.17]	[-0.99, -0.28]
2	-0.14	-0.11	-0.15	-0.14	-0.15	-0.12	-0.14	-0.14
		[-0.77, 0.39]	[-1.54, 0.59]	[-1.09, 0.59]		[-0.95, 0.49]	[-1.32, 0.6]	[-1.06, 0.47]
3	0.2	0.2	0.21	0.21	0.16	0.16	0.22	0.22
		[-0.86, 0.96]	[-1.88, 1.29]	[-1.22, 1.28]		[-1.27, 1.18]	[-1.59, 1.35]	[-1.22, 1.22]
4	0.48	0.45	0.53	0.53	0.42	0.38	0.56	0.55
		[-1.06, 1.58]	[-2.26, 1.97]	[-1.4, 1.92]		[-1.64, 1.8]	[-1.91, 2.07]	[-1.42, 1.94]
5	0.74	0.67	0.82	0.82	0.65	0.58	0.83	0.84
		[-1.31, 2.18]	[-2.67, 2.64]	[-1.62, 2.63]		[-2.02, 2.38]	[-2.25, 2.76]	[-1.66, 2.62]

ensure that the scaling analysis and simulation methods in this study are reliable and mutually compatible. In addition, the scaling functions of the simulated GBM for the studied maturities obviously deviate from those of empirical Treasury rate series except the 5- and 6-year rate series where the scaling exponents of the first three moments show similarity with those of the empirical series.

Moving to the simulated GARCH(1, 1), their scaling exponents for the first two moments of the longer than 4-year maturity are close to -0.55 and -0.14 ,

Table 12.7

The Comparison between Scaling Exponents of Empirical Treasury Rates and Mean Scaling Exponents of Corresponding Simulated Processes. The results are for Treasury rates with less than 5-year maturities. The first left column under each maturity provides the scaling exponents for the first five integer moments. The next three columns provide the average scaling exponents from 1,000 simulations for the MMAR, GBM, and GARCH(1, 1) processes, respectively. The minimum and maximum values of the exponents are reported in parentheses. Emp. means 'Empirical' while Sim. means 'Simulated'.

Moment (q)	4-Year Mean $\tau(q)$				3-Year Mean $\tau(q)$			
	Emp. Series	Sim.		Sim. GARCH (1, 1)	Emp. Series	Sim.		Sim. GARCH (1, 1)
		MMAR Cholesky	Sim. GBM			MMAR Cholesky	Sim. GBM	
1	-0.47	-0.53 [-1.09, -0.18]	-0.56 [-1.16, -0.14]	-0.61 [-1.30, -0.15]	-0.48	-0.50 [-0.90, -0.24]	-0.56 [-1.11, -0.15]	-0.61 [-0.76, -0.3]
2	-0.03	-0.17 [-1.26, 0.49]	-0.14 [-1.4, 0.64]	-0.28 [-1.70, 0.68]	-0.05	-0.11 [-1.02, 0.46]	-0.14 [-1.22, 0.64]	-0.25 [-0.56, 0.29]
3	0.32	0.09 [-1.65, 1.13]	0.22 [-1.71, 1.35]	-0.02 [-2.22, 1.44]	0.28	0.17 [-1.42, 1.06]	0.22 [-1.41, 1.37]	0.03 [-0.41, 0.85]
4	0.62	0.3 [-2.09, 1.71]	0.55 [-2.07, 2.03]	0.18 [-2.79, 2.14]	0.56	0.4 [-1.88, 1.62]	0.54 [-1.63, 2.12]	0.26 [-0.30, 1.36]
5	0.88	0.47 [-2.56, 2.27]	0.84 [-2.44, 2.71]	0.36 [-3.39, 2.81]	0.81	0.6 [-2.36, 2.18]	0.84 [-1.88, 2.85]	0.47 [-0.22, 1.83]

Moment (q)	2-Year Mean $\tau(q)$				6-Month Mean $\tau(q)$			
	Emp. Series	Sim.		Sim. GARCH (1, 1)	Emp. Series	Sim.		Sim. GARCH (1, 1)
		MMAR Cholesky	Sim. GBM			MMAR Cholesky	Sim. GBM	
1	-0.47	-0.49 [-0.96, -0.18]	-0.55 [-1.23, -0.14]	-0.61 [-0.95, -0.27]	-0.47	-0.48 [-0.93, -0.2]	-0.55 [-1.16, -0.17]	-0.61 [-0.77, -0.32]
2	-0.06	-0.12 [-1.06, 0.47]	-0.11 [-1.48, 0.71]	-0.24 [-0.91, 0.39]	-0.07	-0.11 [-1.27, 0.51]	-0.13 [-1.32, 0.66]	-0.27 [-0.59, 0.24]
3	0.24	0.13 [-1.42, 1.03]	0.27 [-1.79, 1.50]	0.06 [-0.92, 0.97]	0.2	0.13 [-1.71, 1.17]	0.24 [-1.58, 1.42]	-0.01 [-0.46, 0.76]
4	0.48	0.33 [-1.87, 1.54]	0.61 [-2.14, 2.25]	0.32 [-0.98, 1.51]	0.42	0.32 [-2.18, 1.79]	0.57 [-1.90, 2.14]	0.20 [-0.38, 1.25]
5	0.68	0.5 [-2.33, 2.04]	0.92 [-2.51, 2.96]	0.55 [-1.07, 2.01]	0.61	0.48 [-2.67, 2.39]	0.87 [-2.25, 2.83]	0.39 [-0.33, 1.72]

respectively. Those values lower to -0.6 and -0.2 , respectively, when the maturities become shorter. The scaling exponents of higher moments show some deviations from those of simulated GBM series as well as from those of the empirical series. In fact, the average of the identified slopes of the simulated GARCH(1, 1) series seems to follow those of the GBM for all studied moments, particularly for the 5-year and 6-year rate series. Thus, like we found earlier for the US Treasury

term structure, these results again suggest that the GARCH(1, 1) model does not properly identify the empirical Treasury rate processes. In particular, the scaling exponents of its fourth (kurtosis!) and fifth moments are higher than those of the empirical interest rate series for the 5-, 6- and 20-year maturities.

As expected, the mean scaling exponents of the simulated MMAR do not accurately reproduce the scaling exponents of empirical series. These results can be attributed to the difficulty of simulation of anti-persistence. The MMARs preserve the scaling properties accurately for the first three moments of 5- and 6-year maturities only. The mean scaling exponents of the fourth and fifth exponents are lower than those of empirical series across maturities except for the 20-year rate, which has the lowest Hurst exponent of all interest rate series. The mean scaling exponents of the simulated MMARs are quite close to those of empirical series for 5-year and 6-year maturity rates. Interestingly, the mean estimated slopes of simulated MMARs for the second moment across all studied maturities are not consistently accurate, or superior to those of simulated GBM and GARCH(1, 1), as suggested by prior studies. Both simulated GBM and GARCH(1, 1) processes closely preserve only the identified slope of the second moment for the 5-year and 6-year maturities.

In Tables 12.6 and 12.7 the minimum and maximum of the 1,000 simulated scaling exponents for each process across maturities are reported in parentheses to represent the identification accuracy. Another measure of accuracy is to measure the range (maximum–minimum) of the simulated scaling exponents. All simulated processes show that their ranges grow very slowly from the first to fifth moments, in line with what is observable from the partition function plots, and similar results appear across all maturities.

For the first moment, the uncertainty ranges of the GBM and GARCH(1, 1) are very similar. However, on average, the uncertainty ranges are wider for the higher moments relative to those of the simulated GBM series. But, unlike the GBM, the MMAR and GARCH(1, 1) have narrower uncertainty ranges. Still, the differences between uncertainty ranges among the three compared processes, based on monthly data, are not as obvious as in the case of the US term structure, where our results are based on daily data (Jamdee and Los, 2006).

5.3. Snapshot vs. Time-Frequency Distributions

In this section, the best model candidate based on 1,000 simulated series is selected by comparing the average frequency distributions they produce and their complete time-frequency distributions scalograms produced by wavelet multiresolution analysis (MRA). A complete performance measurement of the MMAR and the GBM and GARCH(1, 1) models should be based on how effectively the

models preserve the entire time-frequency distribution found in the empirical series and not only the snapshot frequency distributions.

5.3.1. Frequency Distributions Figure 12.4 provides first the snapshot distribution comparisons between those of the empirical Treasury rate series with maturities less than 5 years and their corresponding simulated series.

As seen from panel (a), the solid line exhibits the wavelet compiled density function (distribution) of the 6-month Treasury return series. With a high peak around the mean, thick tails, and a small hump at each side of the tails, the empirical distribution clearly deviates from the Gaussian distribution shown by the dotted-dashed line, while the dashed line shows the compiled distribution of the corresponding simulated GARCH(1, 1) series. Although very similar to each

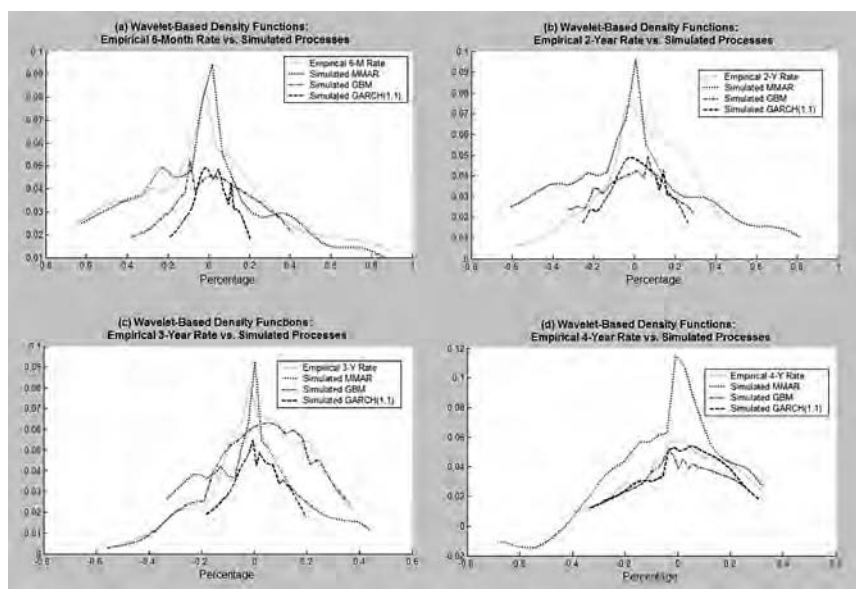


Fig. 12.4. The Comparison of the Density Functions Identified by the wavelet transformation. The solid line indicates the density function of the empirical series. The dashed-dotted line indicates the density function of the simulated GBM. The dotted line indicates the density function of the simulated MMAR. The dashed line indicates the density function of the simulated GARCH(1, 1). Panel (a) shows the comparison of the densities for those series with 6-month maturity. Panel (b) shows the comparison of the densities for those series with 2-year maturity. Panel (c) shows the comparison of those densities from those series with 3-year maturity. Panel (d) shows the comparison of those densities from those series with 4-year maturity

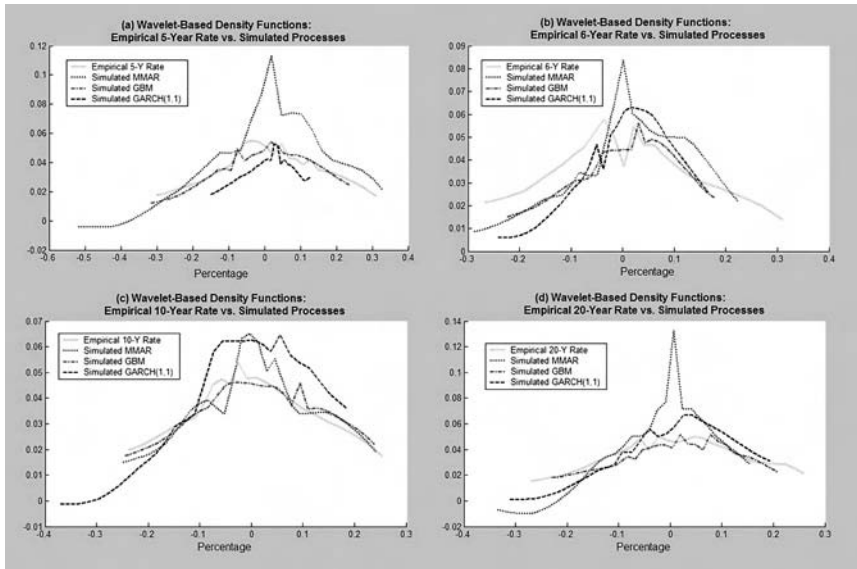


Fig. 12.5. The Comparison of the Density Functions Identified by the wavelet transformation. The solid line indicates the density function of the empirical series. The dashed-dotted line indicates the density function of the simulated GBM. The dotted line indicates the density function of the simulated MMAR. The dashed line indicates the density function of the simulated GARCH(1, 1). Panel (a) shows the comparison of the densities for those series with 5-year maturity. Panel (b) shows the comparison of the densities for those series with 6-year maturity. Panel (c) shows the comparison of those densities from those series with 10-year maturity. Panel (d) shows the comparison of those densities from the interest rate series with 20-year maturity

other, neither the simulated GBM nor the GARCH(1, 1) distribution is similarly shaped as the empirical distribution. Only the dotted line indicating the compiled distribution of the simulated MMAR has a shape that is similar to that of the empirical distribution, since it shows the required high kurtosis. The MMAR does get the kurtosis around the central tendency correct, but deviates from the empirical distribution in the moderate tails.

Panels (b), (c), and (d) provide the comparisons of those compiled densities with the density of the 2-year, 3-year, and 4-year maturities. It appears that, based on the snapshot distributional plots, the MMAR outperforms the other two models for the 6-month and 2- and 3-year interest rates, but the GARCH(1, 1) model is superior for the 4-year maturity. Figure 12.5 shows the comparison of the compiled distributions for the longer than 4-year maturities. For these longer maturities the GBM appears to be superior, based on these snapshot distributions alone.

5.3.2. Scalograms: Time-Scale (Frequency) Distributions The continuous wavelet MRA of the interest rate series results in a scalogram, i.e., a graph with time on the horizontal axis and different scales ($\approx$ inverses of frequencies) on the vertical axis. This scalogram traces the second moment, variance, energy, or squared volatility of the interest rate series over a certain time period of 128 days and over scales 1–12. The absolute values or magnitudes of the localized wavelet resonance coefficients, generated by the wavelet transform at a certain scale and at a given time, are represented by color corresponding to the 100-color bar ranging from red (smallest variance) to blue and reddish-pink (largest variance). Analogously to the coefficients of determination R^2 of bivariate regression projections, the squared wavelet resonance coefficients indicate the correlation between the generic mother wavelet and the interest rate series, at a particular time and scale (= investment horizon) location. Reddish-pink on the displayed scalograms indicates the highest correlation.²

Figure 12.6 provides the scalogram profiles for those empirical and simulated series of interest rates with 2-year maturities. The top left scalogram shows the MRA of the empirical interest rate series. The top right scalogram plot shows the simulated GBM series. The lower right plot provides the MRA of the simulated GARCH(1, 1) series, while the lower left scalogram plot shows the MRAs of the simulated MMAR. The scalogram of the simulated GBM series is white noise. The scalogram of the MMAR and GARCH(1, 1) shows some similarity to that of the empirical series. Nevertheless, none of them clearly indicates superiority over the others in being able to replicate the scaling properties of the empirical series, based on a monthly frequency of observation. This is again in contrast with what we found regarding the US term structure based on a daily frequency of observation (Jamdee and Los, 2006).

Examining other maturities of the Treasury rate series, all scalograms of the simulated GBM series show white noise (as they should!). The differences are obvious for the scalograms of the empirical series, where the red area appears more often over a time period relative to the longer maturity Treasury return series. The shorter the maturities, the more red areas (= virtually no volatility) appear on the scalograms. Thus, the magnitudes of the wavelet resonance coefficients of the shorter maturity Japanese interest rates are smaller at all scales and at all times, which means that they exhibit smaller volatility or risk at all times and at all investment horizons than the longer maturities.

The scalograms of the simulated GARCH(1, 1) processes show improvement over the even white noise of the GBM, as more intermittent red areas are visi-

² Since the wavelets have zero means and unit variance, the analytic basis of a scalogram is thus such that each point in the scalogram provides the local volatility or risk of the time series at a particular point in time and at a particular scale (window or horizon) of observational resolution.

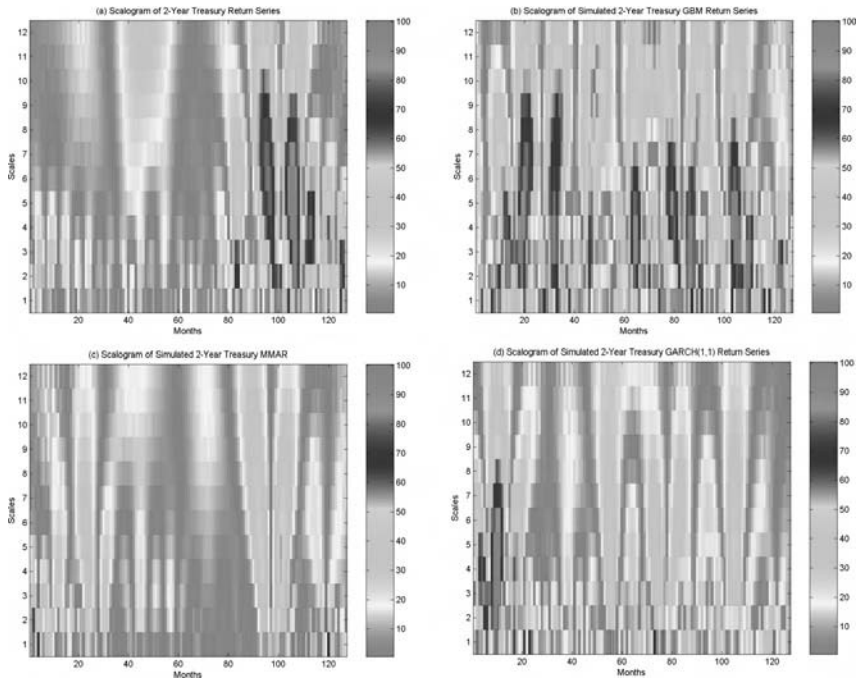


Fig. 12.6. Scalograms of the 2-Year Treasury Return Series and Its Corresponding Simulated Processes. The upper left plot shows the scalogram of the empirical rate over the 128-month period and across the 1–12 scales. The magnitude of wavelet coefficients are colorized with a 100-color scheme. The wavelet used in the transformation process is the Morlet(6) wavelet. The upper right scalogram is calculated from the simulated GBM having the same empirical mean and variance. The lower right plot shows the scalogram of the simulated GARCH(1, 1) return series while the lower left plot shows the scalogram of the simulated MMAR series

ble, indicating clustering, when the maturities are shorter. However, the color of the wavelet resonance coefficients is still different and indicates larger magnitudes than those of their corresponding empirical series. Also, the scalogram of the simulated MMAR is not superior to that of the simulated GARCH(1, 1). Again, the scalograms of simulated MMAR fail to trace the localized variance because of its difficulty to proper model and simulate anti-persistent time series. Its background suggests too small magnitudes of the wavelet resonance coefficients. In contrast, the simulated GARCH(1, 1) scalogram seems to provide a better pattern of colors and, on average, has smaller wavelet resonance coefficients than the scalogram of the MMAR.

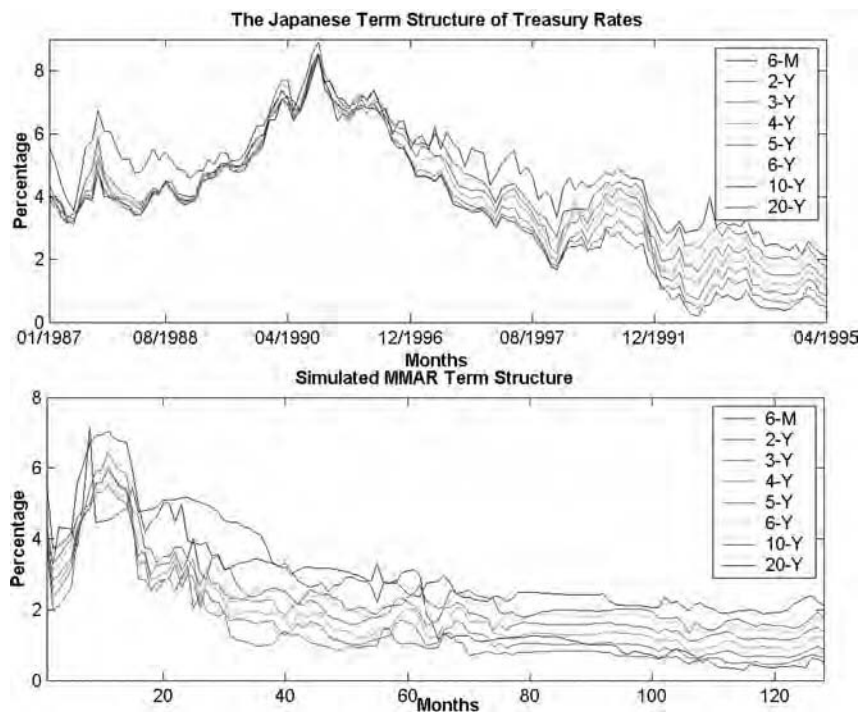


Fig. 12.7. The Resulting Term Structure of the Simulated MMAR. These graphs compare the empirical term structure with a simulated MMAR term structure

Theoretically, there should be a coherent forward relationship among all Treasury term structure nodes, as prescribed by the Rational Expectations Theory, and this forward relationship is explicitly modeled in the case of our 8-factor MMAR system, since all rates satisfy the forward restrictions of that theory. Although by construction, the MMARs are not designed to capture and preserve any multivariate interaction, under the assumption that all markets have access to the same information—even though they process such information in various ways—our system of independent MMAR models tends to produce a fairly coherent system of the observed term structure rates, as seen in Figure 12.7.

The top panel in this Figure 12.7 presents the empirical term structure over the studied time period. One of 1,000 simulated series for each maturity is selected and plotted in the bottom panel. Under an assumption that all maturity rate series are influenced by the same set of new market information (as modeled by us by using the same starting seed for all Monte Carlo simulations), the design of the

Japanese term structure as a system of univariate MMARs does produce some of the coherence among the nodal interest rates. The resulting simulated term “structure” clearly shows some of the empirically observed coherence of Figure 12.1.

Nevertheless, the movement of the simulated term structure is not quite as coherent as that of the empirical term structure. Thus, it still a better modeling of the nonlinear interaction between the nodal interest rate markets is required. Imposing a simple linear covariance structure in the form of a “bandwidth” covariance matrix, as is done in conventional principal components modeling, will not succeed. The reason is that the volatility of each of the nodal interest rate markets does not scale in the same fashion: each of these nodal interest rate markets exhibits a different degree of persistence.

6. CONCLUSION

Treasury rates are the basis default risk-free rates in a particular country, in this case: Japan. A change in the levels and volatilities of these interest rates has a substantial impact on rational financial decision-making in its fundamental bond, stock and real estate markets. Many theories have been proposed to explain the changes of the level, slope and volatility of such a term structure.

Asset pricing modelers attempt to identify price diffusion processes from empirical financial market data. In particular, the Geometric Brownian Motion (GBM) and GARCH models are currently popular. This paper identifies Multifractal Models of Asset Return (MMARs) —recently introduced in the finance literature by Mandelbrot, Fisher and Calvet (1997)—from the eight nodal maturities of the Japanese Treasury rates. The study shows that the Treasury rate series can be uniquely identified as multifractal Brownian motions. This study also improves the current MMARs with better numerical methodologies for the corroboration of the identified Hurst exponents by wavelet multiresolution analysis (MRA).

After analytical, numerical, and graphical analyses of the Japanese Treasury rate series, the corresponding MMARs are synthesized and simulated with the exact Monte Carlo method, following the scientific recommendation of Los (2003), who requires that every identified model be simulated to ensure that it can replicate the empirical features of the observed empirical data. The model performance results of these Monte Carlo simulations of the MMARs are then compared with not only the original empirical time series, but also with the simulations of the corresponding GBM and GARCH(1, 1) processes. Moreover, this study visualizes, analyzes and compares the simulated results using wavelet scalograms, which allow the volatility or risk analysis to be simultaneously conducted over time and scale of observational time resolution (= inverse of frequency of observation).

The Japanese Treasury rates series of all eight nodal maturities are identified as multifractal processes. The measures of their degree of persistence suggests that all eight Japanese term structure series are globally anti-persistent.

The simulated GBM and GARCH(1, 1) tend to outperform the corresponding identified and simulated MMAR models identified from the monthly Japanese interest rates. Based on the snapshot distributional plots, the MMAR outperforms the other two models for the 6-month and 2- and 3-year interest rates, but the GARCH(1, 1) model is superior for the 4-year maturity. For these longer maturities the GBM appears to be superior, based on these snapshot distributions alone. In addition, the simulated GARCH(1, 1) model can more closely trace the volatility of the empirical Treasury series for all eight maturities than the simulated MMAR, but it fails on the higher moments, including, surprisingly, the fourth moment or kurtosis. Our research results bring into focus the failure of all three models and their simulations for anti-persistence series. Improved modeling and simulation technique are still needed to deal with anti-persistence time series. The old paradigm that financial markets are either neutral or persistent (“sticky”) is clearly not true. Some financial markets are significantly anti-persistent.

With monthly data anti-persistence occurs more often than with higher frequency data, for the simple reason that it is rather easy for a market to reverse itself more than once a month, than more than once in a day (as with our daily US Treasury term structure data), or within a minute (as with our FX data). Thus a market’s global degree of persistence has only meaning relative to the frequency of observation. The global degree of persistence is not an absolute measure.

By default, the series of independent MMARs cannot represent a complete model for the term structure. Under the assumption that the same market information affects all maturity markets simultaneously, the MMAR provides some coherence to the dynamic term structure system among the eight maturities. Since there exists accumulated observational evidence suggesting that the term structure of interest rates forms a coherent system, a multivariate system MMAR is needed, e.g., for testing Los’ (2003) cash flow theory of the term structure of interest rates. As of now, the univariate MMAR is an advanced model of both the Rational Expectations and the Market Segmentation Theories of the term structure of interest rates, since it satisfies the theoretical assumptions of **both** theories.

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Chapter 13

CONTINUOUS TIME INTEREST RATE MODELS IN JAPANESE FIXED INCOME MARKETS

K. Ben Nowman

Abstract

In this chapter we consider continuous time single factor models and two factor CKLS and CIRSR models with and without feedback effects of interest rates for use in Japanese fixed income markets. We also consider the multi-factor Generalized Vasicek yield curve model which allows “news” streams representing rumours of interest rate decisions from the BOJ’s Policy Board Meetings on Monetary Policy and economic news of monthly and quarterly economic statistics to effect the yield curve. We use Gaussian estimation methods to estimate the models. Empirical results are given for Japanese CD and Eurocurrency rates. The effect of the BOJ’s zero interest rate policy and quantitative monetary easing policy has had an impact on the implied volatility-level elasticity found to hold in these models and the choice of yield curve models for valuation purposes for use by financial practitioners in Japanese fixed income markets in the future.

1. INTRODUCTION

The modelling of Japanese interest rates using linear and nonlinear continuous time models for use in Japanese fixed income financial markets has been an important research area in finance given the size of the Japanese bond and derivative markets. Many of these models are used in the valuation of bonds and options on bonds and a whole range of fixed income products used in fixed income markets around the world today. At the same time various approaches have been developed in the literature for estimating the parameters of these interest rate models. One common estimation approach is the Generalized Method of Moments method by

Hansen (1982) which has been employed on single factor models using a discrete time approximation. This is the approach adopted in the important study of Chan, Karolyi, Longstaff and Sanders (1992, CKLS, hereafter). Applications to Japanese interest rates include, for example, Tse (1995) and Hiraki and Takezawa (1997).

An alternative approach to estimating nonlinear single factor models using an alternative discrete approximation was proposed by Nowman (1997). This discrete approximation was based on the exact discrete model that was suggested and explored in Phillips (1972) for estimation of continuous time models with discrete data (see also Bergstrom, 1984). In the important Monte Carlo study, Phillips (1972) found that estimates from the exact discrete model have superior finite sample properties compared with those obtained by using an approximate simultaneous model (see Phillips, 1972 for details).

Nowman (1997) used Gaussian estimation econometric methods which were first developed in a series of papers by Bergstrom (1983, 1984, 1985, 1986, 1990). These Gaussian estimation methods were applicable to general linear continuous time models and Nowman (1997) extended their applicability to nonlinear interest rate models involving heteroscedasticity. Examples to Japanese interest rates include Nowman (1998, 2002) and Episcopos (2000).

In another recent important contribution, Yu and Phillips (2001) derived the exact likelihood based on a new Gaussian discrete time form of the CKLS model to estimate the parameters. The method has the interesting property that it uses non-equispaced observations and a time-change transformation in the exact discrete model to achieve Gaussianity. Yu and Phillips (2001) suggested an estimation algorithm which involved using the Nowman (1997) estimator and approximate discrete time model in an intermediate stage and then the Yu–Phillips transformed exact discrete model and exact Gaussian estimator. Monte Carlo evidence reported by them found that the Nowman estimator provided very good estimates of the diffusion term in finite samples but that the Yu and Phillips (2001) approach improves the estimation of the drift and mean reversion parameters in a range of frequencies (see Yu and Phillips, 2001 for further details). The Yu and Phillips (2001) is also applicable to a whole range of other models, for example the CIRSR model and therefore allows one to obtain Gaussianity. A recent application of the Yu–Phillips procedure to Japanese financial markets is given in Nowman and Níguez (2005) on the CKLS, Cox, Ingersoll and Ross (1985, CIRSR thereafter) and Brennan and Schwartz (1980, BRSC thereafter) models.

Gaussian estimation methods have also been applied to multi-factor term structure models. Bergstrom and Nowman (1999) further developed the Gaussian estimation methods for the multi-factor Generalized Vasicek term structure model of Babbs and Nowman (1999). More recently, Nowman (2001) has considered

the Gaussian estimation and forecasting of UK and Japanese interest rates using two factor CKLS and CIRSR models. Brennan and Schwartz (1979) estimated their important two factor term structure model which allowed feedback effects using the estimation procedure of Malinvaud (1966) with the exact discrete model and more recently Saltoğlu (2003) applied Gaussian estimation methods. Because feedback effects are important in the general theory of the term structure of interest rates, Nowman (2003) extended the Gaussian estimation of two factor CKLS and CIRSR models to allow feedback effects in the conditional means as was originally formulated in general continuous time models by Bergstrom (1966). An application to monthly Japanese Eurocurrency rates indicated some evidence of feedback from the one year rate to the one month rate in both the CKLS and CIRSR models. There was also a low volatility-level effect supporting the results in Nowman (2001) without feedback effects. In this chapter we also extend Nowman (2003) to three factor CKLS and CIRSR models with feedback effects.

Our main aims in this chapter are to apply Gaussian estimation methods to different continuous time interest rate models on Japanese daily interest rate data. This chapter is organized as follows: Section 2 outlines the single and multi-factor interest rate models we consider. We also explain the theory of Gaussian estimation for these models. Section 3 presents the data. Empirical results are given in Section 4 and conclusions in Section 5.

2. CONTINUOUS TIME INTEREST RATE MODELS AND ESTIMATION

The development and estimation of continuous time models in fixed income markets has only been a relatively recent development compared to their general application in economics and econometrics. An excellent general survey is provided in Bergstrom (1996)). The general model considered by Bergstrom (1966) is a first order continuous time system specified below:

$$dx(t) = \{A(\theta)x(t) + b(\theta)\} dt + \zeta(dt) \quad (t \geq 0) \quad (1)$$

where $x(t) = \{x_1(t), \dots, x_n(t)\}'$ is a vector whose elements are random processes, $A(\theta)$ is an $n \times n$ matrix whose elements are functions of a vector $\theta = [\theta_1, \dots, \theta_p]$ of structural parameters and $b(\theta)$ is a vector which is a function of θ . The error term can be defined using random measure theory as developed in Bergstrom (1983) in which a more general theory of stochastic differential equations was presented. Following Bergstrom (1983; 1984, Assumption 1) the error term is precisely defined below.

ASSUMPTION 1 (Bergstrom, 1984). $\zeta = [\zeta_1, \dots, \zeta_n]$ is a vector of random measures defined on all subsets of the halfline $0 < t < \infty$ with finite Lebesgue measure such that: $E[\zeta(dt)] = 0$ and $E[\zeta(dt)\zeta'(dt)] = dt \Sigma$ where Σ is a positive definite matrix.

The continuous time model is interpreted in a precise way in Bergstrom (1984, Eq. (29)). An important single factor interest rate model was developed by CKLS in continuous time and is presented below:

$$dr(t) = \{\alpha + \beta r(t)\} dt + \sigma r^\gamma(t) \zeta(dt) \quad (t \geq 0) \quad (2)$$

where $\{r(t), t > 0\}$ is a short term interest rate, α and β are the unknown drift and mean reversion structural parameters; σ is the volatility of the short term rate; γ is the proportional volatility exponent and $\zeta(dt)$ is a white noise error term. As can be seen the conditional mean specification is of the same form as Bergstrom (1966) but the diffusion component is now time varying which differs from the assumption of constant volatility originally formulated in Bergstrom (1966). We assume the error term is defined as in Nowman (1997), see below.

ASSUMPTION 2 (Nowman, 1997). ζ is a random measure defined on all subsets of the halfline $0 < t < \infty$ with finite Lebesgue measure such that: $E[\zeta(dt)] = 0$ and $E[\zeta(dt)^2] = dt$ and $E[\zeta(\Delta_1)\zeta(\Delta_2)] = 0$ for any disjoint sets Δ_1 and Δ_2 on the halfline $0 < t < \infty$.

The special cases of the CKLS model are given in Table 13.1. These included the models of: Merton (1973), Vasicek (1977), Cox, Ingersoll and Ross (1985,

Table 13.1
Single Factor Continuous Time Interest Rate Models

	Model	α	β	σ^2	γ
CKLS	$dr(t) = \{\alpha + \beta r(t)\} dt + \sigma r^\gamma(t) \zeta(dt)$				
Merton	$dr(t) = \alpha dt + \sigma \zeta(dt)$		0		0
Vasicek	$dr(t) = \{\alpha + \beta r(t)\} dt + \sigma \zeta(dt)$				0
CIRSR	$dr(t) = \{\alpha + \beta r(t)\} dt + \sigma r^{1/2}(t) \zeta(dt)$				1/2
Dothan	$dr(t) = \sigma r(t) \zeta(dt)$	0	0		1
GBM	$dr(t) = \beta r(t) dt + \sigma r(t) \zeta(dt)$	0			1
BRSC	$dr(t) = \{\alpha + \beta r(t)\} dt + \sigma r(t) \zeta(dt)$				1
CIRVR	$dr(t) = \sigma r^{3/2}(t) \zeta(dt)$	0	0		3/2
CEV	$dr(t) = \beta r(t) dt + \sigma r^\gamma(t) \zeta(dt)$	0			

CIRSR), Dothan (1978), Brennan and Schwartz (1980, BRSC), Cox, Ingersoll and Ross (1980, CIRVR thereafter), Constant Elasticity of Variance (CEV) model of Cox (1975), Cox and Ross (1976) and the Geometric Brownian Motion (GBM) model. All these models differ in their specification of the conditional mean and diffusion components. The correct specification is of importance to fixed income traders to obtain the correct implied pricing of fixed income securities. CKLS applied GMM and found for the US Treasury market a strong relationship between the volatility of rates and the level of rates $\gamma = 1.5$ and weak evidence of mean reversion in interest rates. In addition, CKLS provided a comparison of prices of bond options implied by the historically estimated CKLS specification and some special cases on US data and found significant variations in the call option values (see also Nowman and Sorwar, 1999, 2005).

In order to apply the Gaussian estimation methods of Bergstrom (1983, 1990) to the different interest rate models Nowman (1997) assumed that as an approximation to the true underlying model given by Eq. (2) that over the interval $[0, T]$, $r(t)$ satisfied the stochastic differential equation

$$dr(t) = \{\alpha + \beta r(t)\} dt + \sigma \{r(t' - 1)\}^\gamma \zeta(dt) \quad (3)$$

where $t' - 1$ is the largest integer less than t and used the assumption of constant volatility over the unit observation period (day, week, month). The discrete model suggested and explored by Phillips (1972) for estimation of continuous time models (see also Bergstrom (1984, Theorem 2)) modified in Nowman (1997, Eqs. (4)–(6)) is used to obtain the Gaussian estimates below

$$r(t) = e^\beta r(t-1) + \frac{\alpha}{\beta} (e^\beta - 1) + \eta_t \quad (t = 1, 2, \dots, T), \quad (4)$$

$$E(\eta_s \eta_t) = 0 \quad (s \neq t), \quad (5)$$

$$\begin{aligned} E(\eta_t^2) &= \int_{t-1}^t e^{2(t-\tau)\beta} \sigma^2 \{r(t-1)\}^{2\gamma} d\tau \\ &= \frac{\sigma^2}{2\beta} (e^{2\beta} - 1) \{r(t-1)\}^{2\gamma} = m_{tt}^2. \end{aligned} \quad (6)$$

The Gaussian estimates are then obtained from the Gaussian likelihood function where $\theta = [\alpha, \beta, \gamma, \sigma^2]$ and

$$L(\theta) = \sum_{t=1}^T \left[2 \log m_{tt} + \frac{\{r(t) - e^\beta r(t-1) - \frac{\alpha}{\beta} (e^\beta - 1)\}^2}{m_{tt}^2} \right], \quad (7)$$

which in Nowman (1997, Eq. (8)) can be defined

$$L(\theta) = \sum_{t=1}^T [2 \log m_{tt} + \varepsilon_t^2]. \quad (8)$$

The transformed residuals $\varepsilon_1, \dots, \varepsilon_T$ can be computed from $m_{tt}\varepsilon_t = \eta_t$. We also report the Box–Pierce type portmanteau test statistic of Bergstrom (1990, Chapter 7, p. 160). It should also be pointed out that the use of this model will help to reduce some of the temporal aggregation bias (see comments in Nowman, 1997).

In modelling the term structure recent research has indicated that more than one factor is needed to adequately model the yield curve and determine bond prices. The early important contribution of Brennan and Schwartz (1979) two factor continuous time model where the two factors were the short and the long term interest rates allowed feedback effects. The CKLS and CIRSR models with conditional mean feedback effects as was considered in Nowman (2003) and originally developed in general continuous time models by Bergstrom (1966) is given below:

$$dr_1(t) = \{\alpha_1 + \beta_1 r_1(t) + \beta_2 r_2(t)\} dt + \zeta_1(dt) \quad (t \geq 0), \quad (9)$$

$$dr_2(t) = \{\alpha_2 + \beta_3 r_2(t) + \beta_4 r_1(t)\} dt + \zeta_2(dt) \quad (t \geq 0) \quad (10)$$

where $r_1(t)$ and $r_2(t)$ represented the short and long term interest rates and $\alpha_1, \alpha_2, \beta_1, \beta_2, \beta_3$ and β_4 are the unknown parameters. Nowman (2001) considered the case where $\beta_2 = 0, \beta_4 = 0$ implying that there is no relationship between the short term and long term interest rates in the conditional mean equations. The error term was assumed in Nowman (2001) to satisfy Assumption 3 below:

ASSUMPTION 3 (Nowman, 2001). ζ_1 and ζ_2 are random measures defined on all subsets of the halfline $0 < t < \infty$ with finite Lebesgue measure, such that: $E[\zeta_1(dt)] = 0$, $E[\zeta_2(dt)] = 0$ and $E[\zeta_1(dt)\zeta_2(dt)] = dt \Sigma(r, t)$ where $\Sigma(r, t)$ was a positive definite matrix assumed in Nowman (2001, Eq. (4)) to be:

$$\Sigma(r, t) = \begin{bmatrix} \sigma_1^2 r_1^{2\gamma_1}(t) & \rho_{12} \sigma_1 \sigma_2 r_1^{\gamma_1}(t) r_2^{\gamma_2}(t) \\ \rho_{21} \sigma_2 \sigma_1 r_2^{\gamma_2}(t) r_1^{\gamma_1}(t) & \sigma_2^2 r_2^{2\gamma_2}(t) \end{bmatrix}.$$

The discrete model used in Nowman (2001, Eq. (6)) based on the proposed model for estimation of Phillips (1972) (see also Bergstrom, 1984, Theorem 2) is

given below where the conditional mean feedback effects of Bergstrom (1966) is now incorporated in Nowman (2003, Eq. (5)):

$$r_t = e^\beta r_{t-1} + (e^\beta - I)\beta^{-1}\alpha + \varepsilon_t \quad (t = 1, \dots, T) \quad (11)$$

where

$$E(\varepsilon_t \varepsilon_t') = \int_0^1 e^{r\beta} \Sigma^*(r, t) e^{r\beta'} dr = \Omega(r, t),$$

$$\alpha = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix}, \quad \beta = \begin{bmatrix} \beta_1 & \beta_2 \\ \beta_4 & \beta_3 \end{bmatrix}, \quad e^\beta = I + \sum_{i=1}^{\infty} \frac{1}{i!} \beta^i$$

and Σ^* is defined in Nowman (2001). The Gaussian estimates are obtained from the Gaussian likelihood function (see Nowman, 2001, Eq. (7))

$$L(\theta) = \sum_{t=1}^T \log(|\Omega(r, t)|) + \sum_{t=1}^T \varepsilon_t' \Omega^{-1}(r, t) \varepsilon_t. \quad (12)$$

We now extend the CKLS for the case of three factors where the factors are the short, medium and long term rates. The general form of the model with feedback effects is now given as

$$\begin{aligned} dr_1(t) &= \{\alpha_1 + \beta_1 r_1(t) + \beta_2 r_2(t) + \beta_3 r_3(t)\} dt + \zeta_1(dt) \quad (t \geq 0), \\ dr_2(t) &= \{\alpha_2 + \beta_4 r_2(t) + \beta_5 r_1(t) + \beta_6 r_3(t)\} dt + \zeta_2(dt) \quad (t \geq 0), \\ dr_3(t) &= \{\alpha_3 + \beta_7 r_3(t) + \beta_8 r_1(t) + \beta_9 r_2(t)\} dt + \zeta_3(dt) \quad (t \geq 0) \end{aligned} \quad (13)$$

where $r_1(t)$, $r_2(t)$ and $r_3(t)$ are the three interest rates. The error term now satisfies Assumption 4 below.

ASSUMPTION 4. ζ_1 , ζ_2 and ζ_3 are random measures defined on all subsets of the half line $0 < t < \infty$ with finite Lebesgue measure, such that

$$\begin{aligned} E[\zeta_1(dt)] &= 0, \quad E[\zeta_2(dt)] = 0, \quad E[\zeta_3(dt)] = 0, \\ E[\zeta_i(dt)\zeta_j(dt)] &= dt \Sigma(r, t), \quad i, j = 1, 2, 3 \end{aligned}$$

where $\Sigma(r, t)$ is now defined as

$$\Sigma(r, t) = \begin{bmatrix} \sigma_1^2 r_1^{2\gamma_1}(t) & \rho_{12} \sigma_1 \sigma_2 r_1^{\gamma_1}(t) r_2^{\gamma_2}(t) & \rho_{13} \sigma_1 \sigma_3 r_1^{\gamma_1}(t) r_3^{\gamma_3}(t) \\ \rho_{21} \sigma_2 \sigma_1 r_2^{\gamma_2}(t) r_1^{\gamma_1}(t) & \sigma_2^2 r_2^{2\gamma_2}(t) & \rho_{23} \sigma_2 \sigma_3 r_2^{\gamma_2}(t) r_3^{\gamma_3}(t) \\ \rho_{31} \sigma_3 \sigma_1 r_3^{\gamma_3}(t) r_1^{\gamma_1}(t) & \rho_{32} \sigma_3 \sigma_2 r_3^{\gamma_3}(t) r_2^{\gamma_2}(t) & \sigma_3^2 r_3^{2\gamma_3}(t) \end{bmatrix}.$$

The CKLS volatility-level assumption is represented by the first element on the diagonal. Similar for factor two and three we have the CKLS volatility-level assumption. The three factor CIRSR case has $(\gamma_1 = 0.5, \gamma_2 = 0.5, \gamma_3 = 0.5)$ now. The Gaussian estimates are obtained from the exact discrete model above and Σ^* has the same structure as Σ but uses the assumption in Nowman (1997) of constant volatility over the unit observation period. The Gaussian likelihood function as defined above now has coefficient matrices:

$$\alpha = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{bmatrix}, \quad \beta = \begin{bmatrix} \beta_1 & \beta_2 & \beta_3 \\ \beta_5 & \beta_4 & \beta_6 \\ \beta_8 & \beta_9 & \beta_7 \end{bmatrix}.$$

Generalized Vasicek Interest Rate Model

The model of Babbs and Nowman (1999) was a general multi-factor model and a subclass of the general Gaussian model of Langetieg (1980). They dealt with the general case of n factors and derived the general pure discount bond price for the model. In the two factor constant parameter case the Babbs and Nowman model assumes that a possible description of the instantaneous interest rate, r , is

$$r(t) = \mu - X_1(t) - X_2(t) \quad (t \geq 0) \quad (14)$$

where μ is a constant representing the long-run average rate and $X_1(t)$ and $X_2(t)$ are unobserved state variables representing the current effect of two streams of “news”. The “news” streams for example may represent interest rate rumours from the Bank of Japan’s Policy Board Meetings on Monetary Policy and long term economic news representing monthly and quarterly economic statistics which all effect the yield curve. The arrival of each type of “news” is modelled by the innovations of Brownian motions, which may be correlated, while the impact of a piece of “news” dies away exponentially as the time since it was received increases. Babbs and Nowman (1999) assumed that $X_1(t)$ and $X_2(t)$ are generated

by the processes

$$dX_1(t) = -\beta_1 X_1(t) dt + c_1 \zeta_1(dt), \quad (15)$$

$$dX_2(t) = -\beta_2 X_2(t) dt + c_2 \zeta_2(dt) \quad (16)$$

where $\beta_1 > \beta_2$ are the mean reversion parameters, $c_1, c_2 > 0$ are diffusion coefficients and ζ_1 and ζ_2 are standard Brownian motion processes with instantaneous correlation ρ so that $E(\zeta_1(dt))^2 = E(\zeta_2(dt))^2 = dt$ and $E(\zeta_1(dt)\zeta_2(dt)) = \rho dt$. Babbs and Nowman (1999) used the Kalman filter to estimate one, two and three factor Generalized Vasicek models on US data and found that the two and three factor models were able to explain the US yield curve. In Bergstrom and Nowman (1999) using the Gaussian estimation methods they derived the exact discrete model and the exact Gaussian likelihood function (Bergstrom and Nowman, 1999, Eqs. (30)–(35)) to estimate the parameters of the two factor case of the Babbs and Nowman (1999) model. This is given below:

$$r(1) - e^{-\beta_2} r(0) - (e^{-\beta_2} - e^{-\beta_1}) X_1(0) - (1 - e^{-\beta_2}) \mu = m_{11} \varepsilon_1, \quad (17)$$

$$\begin{aligned} r(t) - f_1 r(t-1) - f_2 r(t-2) - f_0 &= m_{t1} \varepsilon_t + m_{t,t-1} \varepsilon_{t-1}, \\ t &= 2, \dots, T \end{aligned} \quad (18)$$

where

$$E(\varepsilon_t) = 0, \quad E(\varepsilon_t^2) = I, \quad E(\varepsilon_s \varepsilon_t) = 0, \quad s \neq t, \quad s, t = 1, \dots, T. \quad (19)$$

Equations (17) and (18) is the ARMA representation of the exact discrete model satisfied by the observations $r(0), r(1), \dots, r(T)$ and f_0, f_1 and f_2 are defined in Bergstrom and Nowman (1999). The parameters to be estimated are $\beta_1, \beta_2, c_1, c_2, \mu$ and $X_1(0)$ the initial state value. It was shown in Bergstrom and Nowman (1999) that the correlation parameter ρ had to be set to zero to obtain identification of the diffusion parameters when using time series data in comparison to the panel data approach in Babbs and Nowman (1999) using the Kalman filter. If L denotes minus twice the logarithm of the likelihood then Bergstrom and Nowman (1999, Eq. (33)) obtained the Gaussian estimates from

$$L = \sum_{t=1}^T (\varepsilon_t^2 + 2 \log m_{tt}) \quad (20)$$

where $\varepsilon_1, \varepsilon_2, \dots, \varepsilon_T$ are computed recursively from the formulae

$$\begin{aligned}\varepsilon_1 &= m_{11}^{-1} \{r(1) - e^{-\beta_2} r(0) - (e^{-\beta_2} - e^{-\beta_1}) X_1(0) - (1 - e^{-\beta_2}) \mu\}, \\ \varepsilon_t &= m_{tt}^{-1} \{r(t) - f_1 r(t-1) - f_2 r(t-2) - f_0 - m_{t,t-1} \varepsilon_{t-1}\}.\end{aligned}$$

3. DATA

The interest rates used in this study are daily Japanese interest rates. The first set are daily one and three month Certificate of Deposit (CD) middle rates from the Datastream database over the period January 1993 to March 2005 giving a total of 3181 observations. The second set are Eurocurrency rates of maturities: one week and one, three, six and twelve months over the period March 1990 to July 2002 giving a total of 3228 observations. Table 13.2 shows the basic summary statistics. The average levels of the one and three month CD rates are 0.7016 and 0.7195 percent with standard deviations of 0.9329 and 0.9120 percent. The first six autocorrelations of the levels decay slowly and the first differences are small. The average levels of the Eurocurrency rates range from 2.1392 and 2.1712 percent with standard deviations ranging from 2.5141 and 2.6399 percent. The first six autocorrelations of the levels decay slowly and the first differences are small. The ADF statistics do not reject the null hypothesis of a unit root at the five percent level. Figures 13.1 and 13.2 displays the interest rate levels and also the volatility defined as $|r_t - r_{t-1}|$. As can be seen in Figures 13.1 and 13.2 the CD and Eurocurrency rates have fallen substantially from the beginning of our data sample. The effect of the Bank of Japan's so-called zero interest rate policy (ZIRP) in February 1999 and the 2001 quantitative monetary easing policy should have an impact on the implied volatility-level elasticity found to hold in these models.

4. EMPIRICAL RESULTS

In this section we present the Gaussian estimates (standard errors in brackets) of the different interest rate models. Following Nowman (1997) the explanatory power of each model is compared to the unrestricted model using the maximized Gaussian log likelihood function value.

For the one month CD rate based on the maximized Gaussian log likelihood value compared to the unrestricted model the CEV model performs the best followed by the CIRSR model. The results imply an unrestricted estimate of

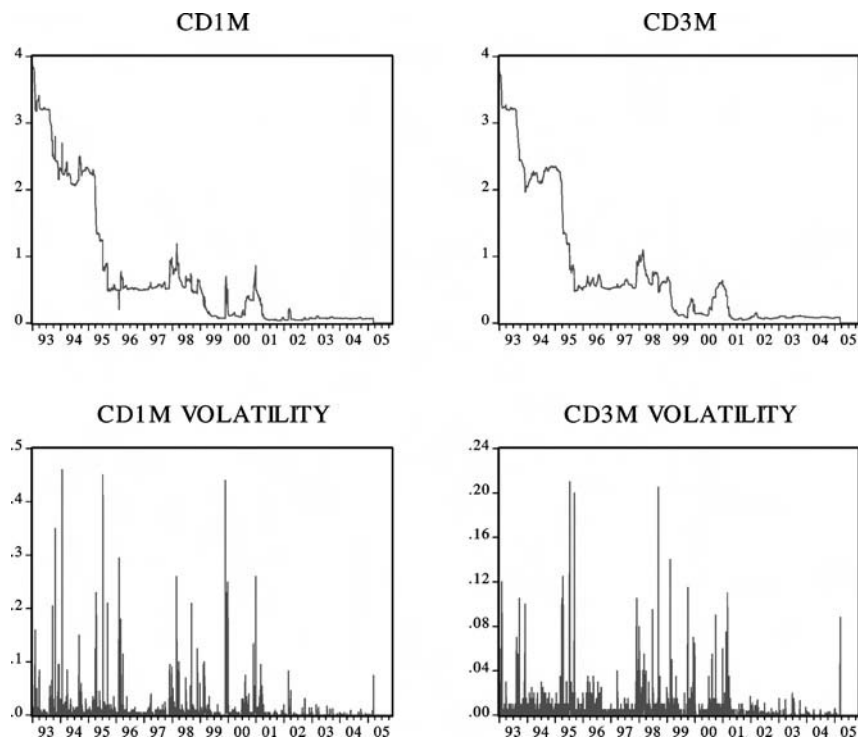


Fig. 13.1. CD Rates

$\gamma = 0.3483$ for the one month rate and highly significant. It indicates a low volatility-level effect for this rate. This compares to the estimate using monthly CD data in Nowman (2002) of $\gamma = 0.0592$. In Shoji and Ozaki (1996) using a different approach they found for monthly one month rate an estimate of $\gamma = 1.5443$ implying a significant change in the volatility-level effect for this rate. There is evidence of mean reversion in the daily one month CD rate for the CKLS model as was also found in Nowman (2002) on monthly data. Based on the χ^2 likelihood ratio test under the null hypothesis that the nested model's restrictions are valid the results imply that we can reject all models except the CEV model. Turning to the S -statistic values the results imply that we can reject the hypothesis of white noise residuals for most models apart from the Dothan, GBM, BRSC and CIRVR models. This compares to the results in Nowman (2002) where none of the models were rejected. This is probably due to the data frequency used in Nowman (2002)

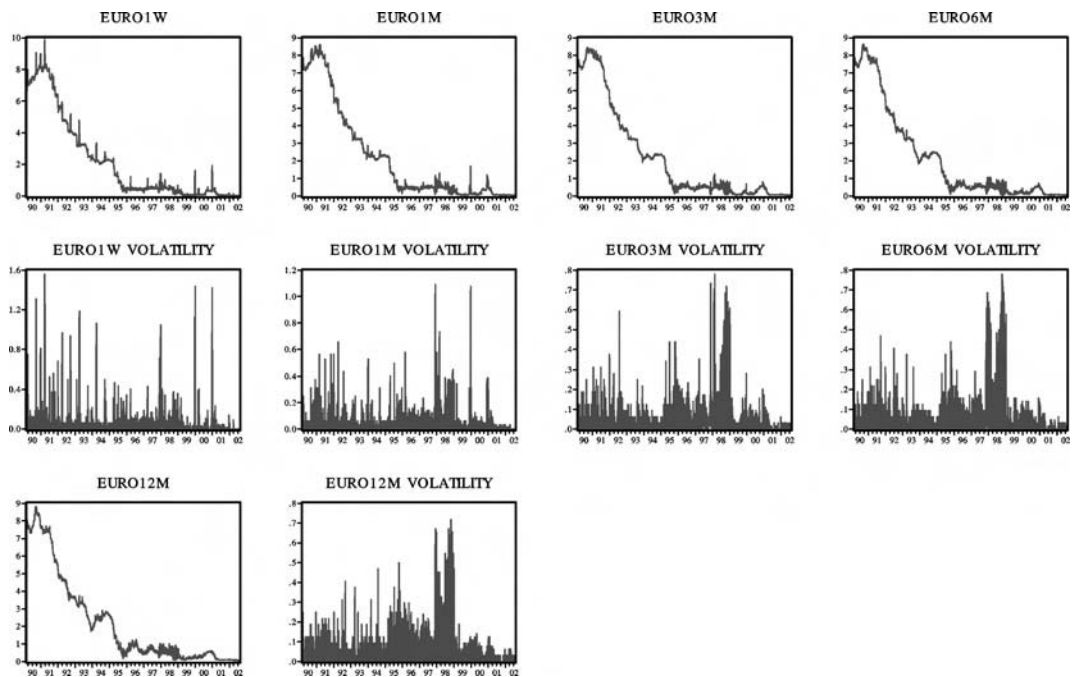


Fig. 13.2. Euro-Currency Rates

Table 13.2

Summary Data Statistics. Mean, standard deviations, and autocorrelations of daily interest rates for Japan

Variable	Mean	S.D.	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6	ADF
CD 1M									
$r(t)$	0.7016	0.9329	0.99	0.99	0.99	0.99	0.98	0.98	-3.1735
$\Delta r(t)$	-0.0011	0.0266	0.00	0.09	0.02	0.01	-0.01	0.004	-37.3789
CD 3M									
$r(t)$	0.7195	0.9120	0.99	0.99	0.99	0.99	0.99	0.98	-3.2351
$\Delta r(t)$	-0.0011	0.0132	0.42	0.19	0.14	0.11	0.10	0.09	-37.1637
Euro 1W									
$r(t)$	2.1712	2.6399	0.99	0.99	0.99	0.99	0.99	0.99	-1.2735
$\Delta r(t)$	-0.0020	0.1196	-0.14	-0.01	-0.02	0.023	-0.17	-0.06	-23.6322
Euro 1M									
$r(t)$	2.1678	2.6339	0.99	0.99	0.99	0.99	0.99	0.99	-0.9527
$\Delta r(t)$	-0.0022	0.0877	-0.20	-0.09	-0.06	-0.01	0.03	-0.03	-36.4577
Euro 3M									
$r(t)$	2.1502	2.6034	0.99	0.99	0.99	0.99	0.99	0.99	-0.7471
$\Delta r(t)$	-0.0022	0.0883	-0.35	-0.02	-0.07	0.02	-0.00	0.04	-22.2766
Euro 6M									
$r(t)$	2.1392	2.5640	0.99	0.99	0.99	0.99	0.99	0.99	-0.9158
$\Delta r(t)$	-0.0023	0.0939	-0.31	-0.12	0.04	-0.06	0.03	0.02	-40.8271
Euro 12M									
$r(t)$	2.1698	2.5141	0.99	0.99	0.99	0.99	0.99	0.99	-1.1233
$\Delta r(t)$	-0.0023	0.0991	-0.36	-0.06	0.06	-0.11	0.05	0.07	-27.1227

Note. The variable $r(t)$ is the level and $\Delta r(t)$ is the daily change, ρ_j is the autocorrelation coefficient of order j , ADF denotes the Augmented Dickey-Fuller unit root statistic with a 5 percent critical value of -3.411.

compared to daily data used here. In addition it should be noted that the test is only approximate in finite samples (see comments in Bergstrom, 1990).

For the three month rate based on the maximized Gaussian log likelihood value compared to the unrestricted model the CEV model performs the best followed by the CIRSR model. The results imply an unrestricted estimate of $\gamma = 0.5253$ for the three month rate and highly significant and very close to the CIRSR model assumption. This compares to the estimate using monthly three month CD data in Nowman (2002) of $\gamma = 0.3354$. There is evidence of mean reversion in the daily three month CD rate for the CKLS model as was also found on monthly data in Nowman (2002). Based on the χ^2 likelihood ratio test under the null hypothesis that the nested model's restrictions are valid the results imply that we can reject all models except the CEV model. Turning to the S -statistic values the results

Table 13.3

Gaussian Estimates of Continuous Time Models of the Short Term Interest Rate: One Month CD Rate

Model	α	β	σ^2	γ	Log-likelihood	χ^2 Test	df	S-Test
CKLS	0.0000* (0.0000*)	-0.0023 (0.0007)	0.0000* (0.0000*)	0.3483 (0.0101)	25148.712			67.1577
Merton	-0.0000* (0.0000*)		0.0000* (0.0000*)	0.0	24511.281	1274.862	2	35.9809
Vasicek	0.0000* (0.0000*)	-0.0021 (0.0005)	0.0000* (0.0000*)	0.0	24519.390	1258.644	1	35.1513
CIRSR	0.0000* (0.0000*)	-0.0024 (0.0010)	0.0000* (0.0000*)	0.5	25031.370	234.684	1	67.4301
Dothan			0.0145 (0.0003)	1.0	23505.288	3286.848	3	21.3425
GBM		0.0015 (0.0016)	0.0144 (0.0003)	1.0	23505.447	3286.530	2	21.3569
BRSC	0.0000* (0.0000*)	-0.0027 (0.0022)	0.0145 (0.0003)	1.0	23507.514	3282.396	1	21.3171
CIRVR			18.4574 (0.4650)	1.5	21317.925	7661.574	3	4.9586
CEV		-0.0018 (0.0006)	0.0000* (0.0000*)	0.3479 (0.0097)	25147.599	2.226	1	67.1774

0.0000* denotes numbers less than 10^{-4} . The critical values at the 5% and 1% significance levels for the Bergstrom S-Test are 21.03 and 26.29, respectively.

imply that we can reject white noise for all the models compared to Nowman (2002).

We now look at the Gaussian estimates of the Eurocurrency rates. For the one week rate based on the maximized Gaussian log likelihood value compared to the unrestricted model the CEV model performs the best followed by the CIRSR model. The results imply an unrestricted estimate of $\gamma = 0.2633$ and highly significant. There is evidence of mean reversion in the one week rate. Based on the χ^2 likelihood ratio test and S-statistics the results imply that we can reject all models and the white noise of residuals.

For the one month rate the CEV model performs the best followed by the Vasicek and Merton models based on the Gaussian likelihood values. The results imply an unrestricted estimate of $\gamma = 0.0463$ for the one month rate and is significant. This compared to an estimate using monthly one month Eurocurrency rate in Nowman (1998) of $\gamma = 0.9838$ and Nowman and Sorwar (1999) $\gamma = 0.3985$ indicating a continued fall in the volatility-level effect for this rate. This is probably due to the fall in rates in Japan over the last few years. Based on the χ^2

Table 13.4

Gaussian Estimates of Continuous Time Models of the Short Term Interest Rate: Three Month CD Rate

Model	α	β	σ^2	γ	Log-likelihood	χ^2 Test	df	S-Test
CKLS	0.0000* (0.0000*)	-0.0018 (0.0004)	0.0000* (0.0000*)	0.5253 (0.0127)	27584.433			446.4426
Merton	-0.0000* (0.0000*)		0.0000* (0.0000*)	0.0	26739.348	1690.170	2	982.6332
Vasicek	0.0000* (0.0000*)	-0.0017 (0.0005)	0.0000* (0.0000*)	0.0	26761.131	1646.604	1	895.190
CIRSR	0.0000* (0.0000*)	-0.0018 (0.0004)	0.0000* (0.0000*)	0.5	27582.207	4.4520	1	464.748
Dothan			0.0013 (0.0003)	1.0	26875.770	1417.326	3	169.667
GBM		-0.0006 (0.0006)	0.0013 (0.0000*)	1.0	26876.247	1416.372	2	168.812
BRSC	0.0000* (0.0000*)	-0.0021 (0.0009)	0.0013 (0.0000*)	1.0	26878.791	1411.284	1	169.017
CIRVR			1.1670 (0.0293)	1.5	25090.359	4988.148	3	53.2598
CEV		-0.0015 (0.0003)	0.0000* (0.0000*)	0.5248 (0.0006)	27583.320	2.2260	1	447.2681

Note. 0.0000* denotes numbers less than 10^{-4} . The critical values at the 5% and 1% significance levels for the Bergstrom S-Test are 21.03 and 26.29, respectively.

test the results imply that we can reject most models apart from the CEV model. Turning to the S -statistic values the results imply that we can reject white noise residuals.

For the three month rate the Vasicek and CEV models perform the best followed by the Merton model based on the Gaussian likelihood values. The results imply an unrestricted estimate of $\gamma = 0.0000$ for the three month rate which is insignificant. Based on the χ^2 test the results imply that we can reject all models except the Vasicek, Merton and CEV models. Turning to the S -statistic values the results imply that we can reject white noise residuals for all models. For the six and twelve month rates the Vasicek and Merton models perform the best followed by the CEV model. The results again imply an unrestricted estimate of $\gamma = 0.0000$ for both rates and is insignificant. Overall the effect of the BOJ's zero interest rate policy and quantitative monetary easing policy has had an impact on the implied volatility-level elasticity found to hold in these models.

Table 13.5

Gaussian Estimates of Continuous Time Models of the Short Term Interest Rate: One Week Euro Currency Rate

Model	α	β	σ^2	γ	Log-likelihood	χ^2 Test	df	S-Test
CKLS	0.0001 (0.0000*)	-0.0025 (0.0010)	0.0000* (0.0000*)	0.2633 (0.0093)	20515.007			240.2999
Merton	-0.0000* (0.0000*)		0.0000* (0.0000*)	0.0	20100.337	829.340	2	193.8079
Vasicek	0.0000* (0.0000*)	-0.0013 (0.0008)	0.0000* (0.0000*)	0.0	20101.789	826.436	1	193.2730
CIRSR	0.0001 (0.0000*)	-0.0036 (0.0017)	0.0001 (0.0000*)	0.5	20205.376	619.262	1	255.2170
Dothan			0.0909 (0.0022)	1.0	18028.119	4973.776	3	165.8319
GBM		0.0221 (0.0078)	0.0885 (0.0022)	1.0	18036.993	4956.028	2	171.2502
BRSC	-0.0000* (0.0000*)	0.0220 (0.0071)	0.0884 (0.0022)	1.0	18036.993	4956.028	1	171.2525
CIRVR			92.6540 (2.2922)	1.5	14731.674	11566.66	3	106.2019
CEV		-0.0013 (0.0010)	0.0000* (0.0000*)	0.2610 (0.0097)	20511.296	7.4220	1	242.2491

Note. 0.0000* denotes numbers less than 10^{-4} . The critical values at the 5% and 1% significance levels for the Bergstrom S-Test are 21.03 and 26.29, respectively.

The mean reversion parameter β implies mean half-lives for the interest rate process (i.e., the expected time for the process to return halfway to its long-term mean, defined as $-\ln(0.5)/\beta$). We report in Table 13.10 the estimated mean half-lives for the CKLS model. For the CD rates the mean half-life are 301 and 385 days for the one and three month rates. This compares to estimates using monthly data in Nowman (2002) of 15 months for CD rates and 16 months for Gensaki rates. For the Eurocurrency rates the mean half-lives are: 277 days for the one week rate, 577 days for the one month rate, 630 days for the three month rate, 533 days for the six month rate and 495 days for the twelve month rate. The half-lives are in line with previous empirical work using continuous time models (see for example, the references in Bergstrom (1996)).

We have also used the likelihood ratio test to compare some nested models with other nested models for the CD rates (see also Nowman (1998)). The results are reported in Table 13.11 based on the log likelihood values given in Tables 13.3–13.4. For the one and three month CD rates we find (at 5% level): for the $\gamma = 0$

Table 13.6

Gaussian Estimates of Continuous Time Models of the Short Term Interest Rate: One Month Euro Currency Rate

Model	α	β	σ^2	γ	Log-likelihood	χ^2 Test	df	S-Test
CKLS	0.0000* (0.0000*)	-0.0012 (0.0006)	0.0000* (0.0000*)	0.0463 (0.0114)	21112.808			226.8407
Merton	-0.0000* (0.0000*)		0.0000* (0.0000*)	0.0	21100.546	24.5240	2	201.9645
Vasicek	0.0000* (0.0000*)	-0.0010 (0.0005)	0.0000* (0.0000*)	0.0	21102.159	21.2980	1	202.0165
CIRSR	0.0001 (0.0000*)	-0.0040 (0.0017)	0.0001 (0.0000*)	0.5	20252.813	1719.990	1	358.4458
Dothan			0.0959 (0.0023)	1.0	17857.249	6511.118	3	254.9300
GBM		0.0224 (0.0061)	0.0933 (0.0023)	1.0	17865.962	6493.692	2	256.2736
BRSC	0.0001 (0.0000*)	-0.0048 (0.0037)	0.0943 (0.0023)	1.0	17893.069	6439.478	1	254.2009
CIRVR			89.5205 (1.5702)	1.5	14661.293	12903.03	3	156.1163
CEV		-0.0011 (0.0005)	0.0000* (0.0000*)	0.0457 (0.0057)	21112.647	0.3220	1	227.0080

Note. 0.0000* denotes numbers less than 10^{-4} . The critical values at the 5% and 1% significance levels for the Bergstrom S-Test are 21.03 and 26.29, respectively.

class of models that the Merton model is rejected against the Vasicek; for the $\gamma = 1$ class of models that the Dothan model cannot be rejected against the GBM and BRSC models for the one month rate, for the three month rate the Dothan model cannot be rejected against the GBM but can be border line rejected against the BRSC model. The GBM model can be rejected against the BRSC model. The Dothan, GBM and CIRVR models are rejected against the CEV model. These results are in line with Nowman (2002). A similar approach can be done for the Eurocurrency rates.

We now discuss the Gaussian estimates (standard errors in brackets) of the two factor CKLS and CIRSR models with and without feedback effects for comparison using the CD rates. Regarding the unrestricted CKLS model with feedback effects the Gaussian estimates of γ_1 and γ_2 are 0.3146 and 0.4921 for the one and three month rates compared to 0.3174 and 0.4914 without feedback effects. This indicates that the feedback effects do not have a major impact on the volatility-level effects. In Nowman (2003) using monthly one and

Table 13.7

Gaussian Estimates of Continuous Time Models of the Short Term Interest Rate: Three Month Euro Currency Rate

Model	α	β	σ^2	γ	Log-likelihood	χ^2 Test	df	S-Test
CKLS	0.0000* (0.0000*)	-0.0011 (0.0006)	0.0000* (0.0000*)	0.0000* (0.0000*)	21077.957			526.6800
Merton	-0.0000* (0.0000*)		0.0000* (0.0000*)	0.0	21076.182	3.5500	2	528.6782
Vasicek	0.0000* (0.0000*)	-0.0011 (0.0006)	0.0000* (0.0000*)	0.0	21077.957	0.0000	1	528.6800
CIRSR	0.0001 (0.0000*)	-0.0058 (0.0015)	0.0002 (0.0000*)	0.5	19643.233	2869.448	1	453.8210
Dothan			0.1952 (0.0048)	1.0	16564.029	9027.856	3	274.0766
GBM		0.0306 (0.0056)	0.1883 (0.0048)	1.0	16571.935	9012.044	2	264.7072
BRSC	0.0001 (0.0000*)	-0.0153 (0.0146)	0.1929 (0.0056)	1.0	16607.755	8940.404	1	283.7524
CIRVR			186.4917 (3.6682)	1.5	12781.630	16592.65	3	430.1976
CEV		-0.0012 (0.0007)	0.0000* (0.0000*)	0.0009 (0.0017)	21077.182	1.5500	1	526.8483

Note. 0.0000* denotes numbers less than 10^{-4} . The critical values at the 5% and 1% significance levels for the Bergstrom S-Test are 21.03 and 26.29, respectively.

twelve month Eurocurrency rates for Japan it was found that the unrestricted CKLS model with feedback effects, γ_1 and γ_2 was estimated to be 0.3673 and 0.4390 compared to 0.3758 and 0.4282 without feedback effects. We also find here that there is evidence of mean reversion in the one and three month rates in both the CKLS and CIRSR models with and without feedback effects. With regards to the feedback case there is evidence in the CKLS and CIRSR models of the one and three month rates affecting each other which compares to Nowman (2003) where it was found that in the CKLS and CIRSR models the one year rate was affecting the one month rate only. The correlations indicate positive 34 to 40 percent between the two factors in the models. Based on the likelihood ratio test the results imply that we can reject the CIRSR with feedback effects and the CKLS and CIRSR without feedback effects against the unrestricted CKLS with feedback. The Gaussian estimation results for the three factor CKLS model with feedback effects estimated using one, six and twelve month Eurocurrency rates are given in Table 13.13. We find that the volatility-level pa-

Table 13.8

Gaussian Estimates of Continuous Time Models of the Short Term Interest Rate: Six Month Euro Currency Rate

Model	α	β	σ^2	γ	Log-likelihood	χ^2 Test	df	S-Test
CKLS	0.0000* (0.0000*)	-0.0013 (0.0006)	0.0000* (0.0000*)	0.0000 (0.0001)	20882.723			426.3580
Merton	-0.0000* (0.0000*)		0.0000* (0.0000*)	0.0	20880.787	3.8720	2	426.4048
Vasicek	0.0000* (0.0000*)	-0.0013 (0.0006)	0.0000* (0.0000*)	0.0	20882.723	0.0000	1	426.3593
CIRSR	0.0001 (0.0000*)	-0.0075 (0.0018)	0.0002 (0.0000*)	0.5	19217.107	3331.232	1	317.6664
Dothan			0.4168 (0.0103)	1.0	15226.486	11312.47	3	548.7526
GBM		0.0375 (0.0110)	0.3999 (0.0109)	1.0	15232.149	11301.14	2	539.9422
BRSC	0.0002 (0.0000*)	-0.0490 (0.0110)	0.4197 (0.0113)	1.0	15293.721	11178.00	1	640.3182
CIRVR			263.6958 (2.4335)	1.5	7469.3594	26826.72	3	12277.05
CEV		-0.0012 (0.0005)	0.0000* (0.0000*)	0.0057 (0.0025)	20873.204	19.0380	1	374.5489

Note. 0.0000* denotes numbers less than 10^{-4} . The critical values at the 5% and 1% significance levels for the Bergstrom S-Test are 21.03 and 26.29, respectively.

parameters imply that $\gamma_1 = 0.0416$, $\gamma_2 = 0.0000$ and $\gamma_3 = 0.0375$. The results for the volatility-level effects are in line with the single factor CKLS model. There is also evidence of feedback between the different interest rates and mean reversion.

The Gaussian estimates in Table 13.14 of the Babbs and Nowman (1999) multifactor yield curve model imply for the one month CD rate that the speed of adjustment parameters β_1 and β_2 are equal to 1.0000 and 0.0043. These estimates imply mean half-lives for the estimated interest rate process of 0.69 days for the first factor and 161 days for the second factor respectively. The first factors fast speed of adjustment reflects the impact that the “news” on rumours on interest rate decisions from the Bank of Japan’s Policy Board Meetings on Monetary Policy will have full impact in under a day on the yield curve and the second speed of adjustment reflecting the longer impact of the economic news of monthly and quarterly economic statistics on the yield curve. The long-run average rate is estimated to be 0.36% which is below the actual sample mean value of about 0.7%.

Table 13.9

Gaussian Estimates of Continuous Time Models of the Short Term Interest Rate: Twelve Month Euro Currency Rate

Model	α	β	σ^2	γ	Log-likelihood	χ^2 Test	df	S-Test
CKLS	0.0000* (0.0000*)	-0.0014 (0.0006)	0.0000* (0.0000*)	0.0000* (0.0001)	20707.174			599.6490
Merton	-0.0000* (0.0000*)		0.0000* (0.0000*)	0.0	20705.077	4.1940	2	600.0200
Vasicek	0.0000* (0.0000*)	-0.0014 (0.0006)	0.0000* (0.0000*)	0.0	20707.174	0.0000	1	599.6490
CIRSR	0.0001 (0.0000*)	-0.0073 (0.0014)	0.0002 (0.0000*)	0.5	19351.189	2711.970	1	560.2702
Dothan			0.1461 (0.0036)	1.0	16577.260	8259.828	3	520.5548
GBM		0.0282 (0.0053)	0.1412 (0.0036)	1.0	16586.295	8241.758	2	504.7450
BRSC	0.0001 (0.0000*)	-0.0208 (0.0059)	0.1438 (0.0036)	1.0	16636.475	8141.398	1	553.9369
CIRVR			140.8851 (3.2714)	1.5	12916.406	15581.53	3	778.9919
CEV		-0.0019 (0.0006)	0.0000* (0.0000*)	0.0037 (0.0024)	20701.672	11.0040	1	625.1526

Note. 0.0000* denotes numbers less than 10^{-4} . The critical values at the 5% and 1% significance levels for the Bergstrom S-Test are 21.03 and 26.29, respectively.

Table 13.10

Implied Mean Half-Lives for CKLS Short Term Interest Rate Model

Interest Rate	Days
CD	
1M	301
3M	385
Euro Currency	
1W	277
1M	577
3M	630
6M	533
12M	495

Table 13.11

A Comparison of Nested Short Term Interest Rate Models: CD Rates

Alternative Unrestricted Model	Restricted Nested Model	χ^2 Test Statistic
CD 1M		
Vasicek	Merton	$\chi_1^2 = 16.218$
GBM	Dothan	$\chi_1^2 = 0.318$
BRSC	Dothan	$\chi_2^2 = 4.452$
BRSC	GBM	$\chi_1^2 = 4.134$
CEV	Dothan	$\chi_2^2 = 3284.622$
CEV	GBM	$\chi_1^2 = 3284.304$
CEV	CIRVR	$\chi_2^2 = 7659.348$
CD 3M		
Vasicek	Merton	$\chi_1^2 = 43.566$
GBM	Dothan	$\chi_1^2 = 0.954$
BRSC	Dothan	$\chi_2^2 = 6.042$
BRSC	GBM	$\chi_1^2 = 5.088$
CEV	Dothan	$\chi_2^2 = 1415.100$
CEV	GBM	$\chi_1^2 = 1414.146$
CEV	CIRVR	$\chi_2^2 = 4985.922$

Turning to the three month CD rate the speed of adjustment parameters β_1 and β_2 are equal to 1.0000 and 0.0039. These estimates imply mean half-lives of 0.69 days for the first factor and 177 days for the second factor, respectively. The long-run average rate is estimated to be 0.35% below the actual sample mean value of about 0.7%. Overall the estimates are satisfactory by the Gaussian estimation method.

5. CONCLUSIONS

In this chapter we considered a range of continuous time models of interest rates for use in Japanese fixed income markets. We considered single factor models of the short rate in which the specification of the drift and volatility differs and two factor CKLS and CIRSR models with and without feedback effects. We also considered the multi-factor Generalized Vasicek yield curve model of Babbs and Nowman (1999) which allowed “news” streams which represented rumours of

Table 13.12
Gaussian Estimates of Two Factor Models

Parameters	CKLS Feedback	CIRSR Feedback	CKLS	CIRSR
α_1	-0.0000* (0.0000*)	-0.0000* (0.0000*)	0.0000* (0.0000*)	0.0000* (0.0000*)
α_2	-0.0000* (0.0000*)	-0.0000* (0.0000*)	0.0000* (0.0000*)	0.0000* (0.0000*)
β_1	-0.0719 (0.0060)	-0.0686 (0.0088)	-0.0021 (0.0006)	-0.0022 (0.0008)
β_2	0.0709 (0.0061)	0.0670 (0.0087)		
β_3	0.0206 (0.0028)	0.0182 (0.0033)	-0.0019 (0.0004)	-0.0019 (0.0003)
β_4	-0.0224 (0.0027)	-0.0201 (0.0033)		
γ_1	0.3146 (0.0092)	0.5	0.3174 (0.0088)	0.5
γ_2	0.4921 (0.0117)	0.5	0.4914 (0.0116)	0.5
σ_1^2	0.0000* (0.0000*)	0.0000* (0.0000*)	0.0000* (0.0000*)	0.0000* (0.0000*)
σ_2^2	0.0000* (0.0000*)	0.0000* (0.0000*)	0.0000* (0.0000*)	0.0000* (0.0000*)
ρ_{12}	0.3954 (0.0154)	0.3416 (0.0172)	0.4042 (0.0150)	0.3508 (0.0154)
Log LF	53076.10	52887.85	53009.01	52824.25
χ^2 Test		376.50	134.18	503.70

Note. 0.0000* denotes numbers less than 10^{-4} .

interest rate decisions from the Bank of Japan's Policy Board Meetings on Monetary Policy and long term economic news representing monthly and quarterly economic statistics to effect the yield curve. The continuous time models were explained and estimated using recently developed Gaussian estimation methods for these models. The effect of the BOJ's zero interest rate policy and quantitative monetary easing policy has had an impact on the empirical implied volatility-level elasticity found to hold in these models and the choice of yield curve models for valuation purposes for use by financial practitioners in Japanese fixed income markets in the future.

Table 13.13
Gaussian Estimates of Three Factor Model

Parameters	Estimates
α_1	-0.0001 (0.0000*)
α_2	-0.0001 (0.0000*)
α_3	0.0004 (0.0000*)
β_1	-0.0457 (0.0046)
β_2	0.0510 (0.0030)
β_3	-0.0048 (0.0017)
β_4	-0.0370 (0.0046)
β_5	0.0203 (0.0052)
β_6	0.0156 (0.0030)
β_7	-0.0390 (0.0050)
β_8	0.0213 (0.0029)
β_9	0.0153 (0.0022)
γ_1	0.0416 (0.0140)
γ_2	0.0000* (0.0000*)
γ_3	0.0375 (0.0176)
σ_1^2	0.0000* (0.0000*)
σ_2^2	0.0000* (0.0000*)
σ_3^2	0.0000* (0.0000*)
ρ_{12}	-0.0316 (0.0001)
ρ_{13}	0.0330 (0.0535)
ρ_{23}	0.0363 (0.0001)
Log LF	62812

Note. 0.0000* denotes numbers less than 10^{-4} .

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Table 13.14
Gaussian Estimates of Generalized Vasicek Two Factor Model

Parameters	Estimates
CD 1M	
β_1	1.0000 (0.0050)
β_2	0.0043 (0.0007)
c_1	0.0000* (0.0055)
c_2	0.0369 (0.0004)
μ	0.3604 (0.1314)
$X_1(0)$	5.2654 (0.0550)
Log LF	8906
CD 3M	
β_1	1.0000 (0.0050)
β_2	0.0039 (0.0005)
c_1	0.0000* (0.0050)
c_2	0.0275 (0.0003)
μ	0.3515 (0.0980)
$X_1(0)$	5.1134 (0.0408)
Log LF	9849

Note. 0.0000* denotes numbers less than 10^{-4} .

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Market Integration

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Chapter 14

HOW INTEGRATED ARE THE EQUITY AND DEBT MARKETS? A COMPARATIVE STUDY OF JAPANESE AND THE U.S. CAPITAL MARKETS

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Abstract

This paper studies the long-run comovement of Japanese and U.S. stock and bond markets using two different cointegration tests. Unlike the previous studies, we use both the Engle–Granger cointegration test and the Canonical Cointegration Regression (CCR) method to test the long-run comovement of asset returns. The Engle–Granger cointegration tests indicate that there is little evidence on cointegration between the bond and stock markets of the two countries, which is consistent with the results found in the previous studies. Using CCR method, however, we find more favorable evidence of comovement between the asset market returns. Tests with monthly data show some evidence of cointegration between the asset return series, while with quarterly data we find that most of the time series of asset returns are cointegrated. Our empirical study presents indirect evidence of the effects of cross investments leading to more integration of asset markets.

1. INTRODUCTION

Stocks and bonds are two classes of assets that are available for investors interested in diversifying their portfolios. With the relaxation of cross-border investment restrictions and the resultant availability of stocks and bonds issued by firms and governments of different countries, the set of assets available for investment has increased dramatically in recent years. Based on the classic portfolio optimization models of Markowitz (1952), the benefit of diversification depends on

the correlation between the returns of these two classes of assets. Even though the portfolio optimization models look at the correlation between the asset returns, with the time-varying nature of asset return correlations, it is necessary to also investigate the long run comovement of asset returns.

In this paper we investigate the long run comovement of the following categories of assets from Japan and the U.S.—equities, short and long-term government bonds and corporate bonds.¹ Japan and the U.S. are the largest two economies of the world, and the equity and bond markets of these two countries are two of the largest in their respective categories. There is considerable cross listing of Japanese equities in U.S. markets; at the same time the Japanese are the largest investors in the U.S. Treasury bond market. These two factors can lead to the assumption that there must be a certain degree of comovement between the asset markets of these two countries. Therefore, the main thrust of this paper is to see whether there is long run comovement between the asset returns within the national market and across the markets of the two countries. From a practitioner's perspective, understanding the nature of the comovement of asset returns can result in better asset allocations.

One possible explanation for the comovement of stock and bond returns is based on the concept of “flight-to-quality” (Barsky, 1989). When investors perceive that equity markets are going to be riskier in the future, they tend to sell their equity holdings and move the money into less risky government bond markets. If demand in the bond market increases, bond prices will go up and the bond yields will go down. On the other hand, when the investors sell, both the stock prices and the stock returns will go down. According to this popular notion, during times of increased uncertainty in the stock market, investors will shift their funds to bonds. Bond prices will increase relative to the stock prices, and comovement between the stock and bond returns will become less positively correlated. In fact, this flight to quality can result in sustained negative correlation between the stock and government bond returns.

There are two main channels through which information affects the relationship between the stock and bond markets: (1) common sources of information influencing the expectations in both stock and bond markets simultaneously, and (2) sources of information that not only alter expectations in one market but spill over into another market (Kim, Moshirian and Wu, 2006). For example, downgrading of the debt of a firm can affect both the stock price and bond price of the firm, while an increase in interest rates by the central bank may have a more pronounced effect on the bond market and less so on the stock market. However,

¹ Campbell and Hamao (1992) also test the integration between the U.S. and Japanese capital markets using the predictability of monthly excess returns on U.S. and Japanese equity portfolios over the U.S. Treasury bill rate. See Campbell and Hamao (1992) for details.

a shock in one market may cause asset rebalancing, which then spills over into another market; in this sense the information affecting one market can affect the other market and hence increase the comovement between the two markets.

The next step is to see if there is any comovement between the asset markets in two different countries. A possible explanation for comovement of asset markets in two countries is liberalization of regulations with respect to cross-country investments (Berben and Jansen, 2005). With the increase in liberalization of regulations and the consequent globalization of the capital markets, it can be perceived that comovement between equity markets must also have increased during the past twenty years. Most of the evidence is anecdotal, where certain dramatic events in a country or a group of countries create ripples that move through the entire world markets. Detailed empirical studies are required to verify this comovement of markets.

There are a few studies on the linkages of international bond markets, while there are a fairly large number of papers on the linkages of stock markets. In a largely deregulated international bond market, bond yields, which are analogous to asset prices, should to a certain degree move together. On the other hand, if bond yields are largely the resultant of the monetary policies of a given country, then these should exhibit comovements to a lesser degree. Within the bond markets it is possible to have differences between the short and long-term covariances of bond returns from different countries. The long-term covariances between the two bond markets may be high, indicating that the bond markets are integrated and hence the benefit of diversification is lower. On the other hand, the short-term covariances may be lower, which gives a higher diversification benefit.

The empirical studies on comovement of asset returns can be divided into two categories. The first group of studies looks into the comovement and linkages between the bond markets of various countries. The comovement of stock and bond markets within a country as well as across a group of countries are studies by the second group. Among the studies that belong to the first group, Perignon, Smith and Villa (2005) find the U.S. bond returns share only one common factor of change in the level of domestic term structure with German and Japanese bond returns. On the other hand, Driessen, Melenberg and Nijman (2003) identify the five factors in bond return from the U.S., Japan and Germany and find that these factors are related to level and steepness of the term structure in the respective countries. Clare, Thomas and Wikens (1995) find that the bond markets of major industrial countries have unique characteristics. They attribute this uniqueness to taxation differences, maturity structures, investment cultures, issuance patterns

and institutional arrangements.² Mills and Mills (1991) find that the bond yields are not cointegrated, and that in the long run they are determined by the domestic fundamentals.³ As in Driessen, Melenberg and Nijman (2003), a possible explanation for this is that many investors prefer to invest in long-term government bonds issued by their own governments. There is a potential for reducing the portfolio risk by holding a diversified portfolio of bonds issued by different countries, which may not be fully utilized by the domestic investors.

Among the studies that look into the comovement of stock and bond returns within a country as well as across a group of countries, Shiller (1982) finds little evidence on comovement between equity prices, bond and land prices, while Campbell and Shiller (1988) show that dividend price ratios are uncorrelated with subsequent real interest rates.⁴ Furthermore, Kim, Moshirian and Wu (2006), Li (2002) and Schulman and Miller (1999) study the relationship between the stock and bond returns of selected countries. Kim, Moshirian and Wu (2006) find that the bond markets are largely segmented within the context of the countries studied. Li (2002) reports that the major trends in stock and bond correlation are determined by the uncertainty about the expected inflation. Schulman and Miller (1999) find that the correlation between the stock and bond returns are abnormally high during periods of high inflation.⁵

There are two theoretical models for movement of stock and bond prices/returns to move together. One is the standard consumption based asset pricing model and the other is VAR framework. Barsky (1989) employs the standard model and reports that the changes in risk and real economic productivity growth affect the joint movement of the stock and bond prices.⁶ With VAR framework, Campbell and Ammer (1993) find that the news about future excess returns account for most of the variation in excess stock returns, while the bond returns are mostly affected by news of future inflation. This explains the low positive correlation between the stock and bond returns in the post World War II era in the U.S.⁷ Some studies further examine the relationship between stock and bond markets by investigating the volatility linkages of those markets while others examine the relationship be-

² They further presume that the uniqueness of the bond markets might be due to the fact that the macroeconomic policies of the governments are, in general, not coordinated and also that different economies may be at different points in the economic cycles.

³ Both Clare, Thomas and Wkens (1995) and Mills and Mills (1991) use cointegration methodology to test the interlinkages between government bond markets of the U.K., the U.S., Germany and Japan.

⁴ Both Shiller (1982) and Campbell and Shiller (1988) study the U.S. market only.

⁵ See Kim, Moshirian and Wu (2006), Li (2002) and Schulman and Miller (1999) for details.

⁶ Similar conclusions are reached by Bekaert and Grenadier (2001).

⁷ Engsted and Tanggaard (2001) use the same methodology of Campbell and Ammer (1993) to Danish stock and bond markets. The results indicate that excess stock and bond returns are negatively correlated for the Danish market.

tween stock markets and other factors such as yield curves and a set of economic variables.⁸

From the studies cited above it is unclear whether there is any real long-term comovement between the bond market returns as well as between the bond market and the stock market returns. In this paper we use the cointegration methodology to test whether there is any comovement between the stock and bond markets in Japan and the U.S. A practical reason for this study is also to test indirectly whether the sizable presence of Japanese investors in the U.S. Treasury bond market and the cross-listing of Japanese stocks in the U.S. market have contributed to long-term comovement between the equity and bond markets of these two countries. Our empirical study finds that there is systematic long-run comovement between the asset returns of Japanese and U.S. markets with quarterly data, which presents indirect evidence of the effect of cross investments leading to more integration of asset markets of the two countries.

The rest of the paper is organized as follows. Section 2 describes the econometric methodology used in this study. The details of the data are described in Section 3. In Section 4 the results of the study are discussed, and Section 5 concludes this paper.

2. ECONOMETRIC METHODOLOGY

2.1. Unit Root and the Engle–Granger Cointegration Tests

As a preliminary step, we test for a unit root in variables to check stationarity of the variables concerned. To test for a unit root (or the difference stationary process), we employ both the Augmented Dickey–Fuller (ADF) test (1979) and the Phillips–Perron (PP) test (1988) based on the following regressions:

- (a) Augmented Dickey–Fuller regression: $\Delta x_t = a_0 + \rho x_{t-1} + \sum_{i=1}^m \beta_i \Delta x_{t-i} + \eta_t$,
- (b) Phillips–Perron regression: $x_t = \mu + \alpha x_{t-1} + \varepsilon_t$.

The difference between the two unit root tests lies in their treatment of any ‘nuisance’ serial correlation. The PP test tends to be more robust to a wide range

⁸ DeGoeij and Marquering (2002) and Fleming, Kirby and Ost diek (1998) investigate the volatility linkages of stock, bond and money markets. The relationship of yield curves and risk premiums of stocks of eight industrialized countries is examined by McCown (2001). Nasseh and Strauss (2000) look at the long-run relationship between the stock prices and domestic and international economic activity such as industrial production, business surveys of manufacturing orders, short- and long-run interest rates, foreign stock prices and production of six European economies. See DeGoeij and Marquering (2002), Fleming, Kirby and Ost diek (1998), McCown (2001), and Nasseh and Strauss (2000) for details.

of serial correlation and time-dependent heteroscedasticity. The null hypothesis is that a series is nonstationary: $\rho = 0$ in the ADF test, and $\alpha = 1$ in the PP test.

After testing for stationarity of the variables, we employ the following Engle–Granger cointegration test (1987) to estimate the long-run equilibrium relationship between two variables:

$$y_t = \alpha + \beta x_t + \varepsilon_t. \quad (1)$$

If both y_t and x_t are $I(1)$, and ε_t , the bivariate spreads between y and x , is stationary, it indicates that y and x are cointegrated order of $(1, 1)$. The residual series are the estimated values of the deviations from the long-run relationship.

2.2. Canonical Cointegration Regression (CCR) Method

We further employ Park's (1992) Canonical Cointegration Regression (CCR) method to estimate a cointegrating vector and to test cointegration between the variables in which we are interested. One reason for using CCR is that Monte Carlo simulations in Park and Ogaki (1991) have shown that the CCR estimators have better small sample properties in terms of mean squared error than Johansen's (1988) Maximum Likelihood (ML) estimators when the sample size is small and even when the Gaussian VAR structure assumed by Johansen is true. Kahn and Ogaki (1992) find that Park's tests for the null of cointegration have reasonable small sample properties.

Consider a cointegrated system

$$y_t = X_t' \gamma + \varepsilon_t, \quad (2)$$

$$\Delta X_t = v_t \quad (3)$$

where y_t and X_t are difference stationary, and ε_t and v_t are stationary with zero mean. Here, y_t is a scalar and X_t is an $(n - 1) \times 1$ random vector. Let

$$w_t = (\varepsilon_t, v_t'). \quad (4)$$

Define $\Phi(I) = E(w_t w_{t-I}')$, $\Sigma = \Phi(0)$, $\Gamma = \sum_{i=0}^{\infty} \Phi(i)$, and $\Omega = \sum_{i=-\infty}^{\infty} \Phi(i)$. Here Ω is the long run covariance matrix of w_t . Partition Ω as

$$\Omega = \begin{bmatrix} \Omega_{11} & \Omega_{12} \\ \Omega_{21} & \Omega_{22} \end{bmatrix} \quad (5)$$

and partition Γ conformably. Define $\Omega_{11,2} = \Omega_{11} - \Omega_{12} \Omega_{22}^{-1} \Omega_{21}$ and $\Gamma_2 = (\Gamma'_{12}, \Gamma'_{22})$. The CCR procedure assumes that Ω_{22} is positive definite, implying

that X_t is not itself cointegrated. This assumption ensures that $(1, -\gamma)$ is the unique cointegrating vector. The OLS estimator in Eq. (2) is super-consistent because the estimator converges to γ at the rate of T (sample size) even when $\Delta x(t)$ and $u(t)$ are correlated. However, the OLS estimator is not asymptotically efficient in this case. To obtain an asymptotically efficient OLS estimator, Park suggests a transformed model:

$$y_t^* = y_t + \Pi_y' w_t, \quad (6)$$

$$X_t^* = X_t + \Pi_x' w_t. \quad (7)$$

Because w_t is stationary, y_t^* and X_t^* are cointegrated with the same cointegrating vector $(1, -\gamma)$ as y_t and X_t for any Π_y and Π_x . The idea of CCR is to choose Π_y and Π_x , so that the OLS estimator is asymptotically efficient when y_t^* is regressed on X_t^* . This requires

$$\Pi_y = \Sigma^{-1} \Gamma_2 \gamma + (0, \Omega_{12} \Omega_{22}^{-1})', \quad (8)$$

where $\Pi_y = \Sigma^{-1} \Gamma_2$.

In practice, the long-run covariance parameters in these formulas are estimated, and the estimated Π_y and Π_x are used to transform y_t and X_t . As long as these parameters are estimated consistently, the CCR estimator is asymptotically efficient.

The CCR estimators have asymptotic distributions that can be essentially considered as normal distributions, implying that their standard errors have the usual interpretation. The $H(p, q)$ tests basically apply Park's $G(p, q)$ tests to CCR residuals for the null of stationarity to OLS regressions [see Park (1992) for more explanation]. The $H(p, q)$ statistic converges in distribution to a χ_{p-q}^2 random variable under the null hypothesis of cointegration. In particular, the $H(0, 1)$ statistic tests the deterministic cointegrating restriction and the $H(1, q)$ statistic tests stochastic cointegration.

2.3. Bivariate Granger Causality Tests

We employ Granger causality tests to gain more insight into the dynamic relationship between two variables. Causality tests can provide useful information on whether knowledge of past security price movements improve forecasts of current and future movements in the other security prices, and vice versa. Formally, if the prediction of y using past x is more accurate than without using past x in

the mean square error sense [i.e., if $\sigma^2(y_t|I_t) < \sigma^2(y_t|I_t - x_t)$, where I_t is the information set], we say that x Granger causes y , denoted by $x \xrightarrow{G.C.} y$.

The causal relations are based on a bivariate causality test between one security performance and another security index. Therefore, to determine whether a market index Granger-cause another asset returns, or vice versa, the following system of equations is estimated:

$$\Delta y_t = a + \sum_{i=1}^m \alpha_i \Delta y_{t-i} + \sum_{i=1}^m \beta_i \Delta x_{t-i} + \varepsilon_t \quad (9)$$

where Δy (Δx) represents the first-differenced series of a log variable. The first-differenced series (the usual definition of returns) are stationary variables, and the disturbance terms, ε_t , in Eq. (9) is assumed to have zero means, constant variances, and be individually serially uncorrelated. The null hypothesis is that x does not Granger-cause y if $\beta_i = 0$ for all i in (9).

3. DATA

The data for this study include 252 monthly and 84 quarterly observations, covering a 21-year period from January 1984 to December 2004.⁹ The major market indexes under study are stock indices, 10-year government bond and 3-month government bill total return indexes (and yields) of the United States (US) and Japan (JP) obtained from Datastream International.

Most of the previous studies (e.g., Clare, Thomas and Wikens, 1995; Sutton, 2000; Smith, 2002) use monthly observations for the cointegration tests. Since cointegration tests work better with low frequency data, we also use quarterly data to examine the long-run relationship between the financial markets of the U.S. and Japan.

For the Japanese market, Nikkei 225 Stock Average Price Index is used as a proxy for the aggregate Japanese stock market performance. We use the total return indexes and yields of Japanese 10-year government bond and 3-month Treasury bill. These indexes represent the total return (including reinvested coupon payments) to the investor from a representative portfolio of government bonds with the above maturities. The indexes are obtained both in local currency and U.S. dollar terms, with returns measured in both Japanese yen and US dollars. In general, the results in local currency terms are more relevant if exchange rate risk

⁹ Japanese 3 month Treasury bill index (JP3MIL) and U.S. 3 month Treasury bill (US3MI) indexes begin from January 1986.

is fully hedged in international investment (Barr and Priestley, 2004). By contrast, the results in U.S. dollar terms reflect the possible benefits of international bond diversification to U.S. investors (Smith, 2002). Yields on Japanese AAA and B corporate bonds are used to test the long run comovement with the U.S. corporate bond yields.¹⁰

For the U.S. market, Standard & Poor's 500 Price Index is used as a proxy for the aggregate U.S. stock market performance. We use the total return indexes and yields of the U.S. 10-year Treasury bond and 3-month Treasury bill as well as the yields on AAA and BAA corporate bonds.

4. EMPIRICAL RESULTS

Table 14.1 provides a summary listing of the variables used in the study. Table 14.2 reports some of the descriptive statistics for the variables. Yields on debt securities of both Japan and the U.S. have been declining over the sample period.

Japanese and U.S. stock, government bond and bill indices are plotted in Figures 14.1 and 14.2. Each figure shows log series of stock, government bond, and bill total return indices by setting the initial values at zero. As evidenced from these figures, equity, government bond and bill markets behaved very differently over the sample period. The Japanese stock market peaked in the year 1989 and has been through a prolonged period of decline since then. On the other hand, the U.S. stock market had a dramatic drop in 1987 and a more prolonged decline after the bursting of the Internet bubble in the year 2001. Japanese short term interest rates are close to zero for the past ten years, while the U.S. short term interests have generally declined in the past five years. A cursory observation of these figures indicates that all the series seem to be non-stationary.

Before we test the comovement of the markets, it is necessary to conduct more formal tests for non-stationarity of the time series. Two standard procedures that we employ for this purpose are the ADF test and the PP test. The optimal lags are selected by minimizing Akaike's (1974) information criterion (AIC) and Schwartz's (1978) Bayesian information criterion (SBC). The null hypothesis for both procedures is that a unit root exists and in Table 14.3 we report the results for these tests. The stock index return series, as well as the long-term government

¹⁰ Japanese AAA and B corporate bond yields are available beginning from January 1997. For corporate bonds, we use yields on corporate bonds of the U.S. and Japan because corporate bond market indexes are not available. U.S. and Japanese AAA corporate bonds, and U.S. BAA and Japanese B rated corporate bonds are paired for this study, respectively given lack of Japanese BAA corporate bond data.

Table 14.1
Variable Names and Descriptions

Variable Name	Variable Description
NIKKEI	Nikkei 225 stock average price index
NIKKEIS	Nikkei 225 stock average price index (U.S. dollar denominated)
JP10I	Japan 10 year government bond total return index (U.S. dollar denominated)
JP10IL	Japan 10 year government bond total return index (Japanese Yen denominated)
JP3MI	Japan 3 month government bill total return index (U.S. dollar denominated) (1/3/86–12/31/04)
JP3MIL	Japan 3 month government bill total return index (Japanese Yen denominated) (1/3/86–12/31/04)
JP10Y	Japan 10 year government bond yield
JPAAA	Japan AAA corporate bond yield (1/3/97–12/31/04)
JPB	Japan B corporate bond yield (1/3/97–12/31/04)
SP	S&P 500 composite price index
US10I	U.S. 10 year government bond total return index
US3MI	U.S. 3 month government bill total return index (1/3/86–12/31/04)
US10Y	U.S. 10 year government bond yield
US3MY	U.S. 3 month government bill yield
USAAA	U.S. AAA corporate bond yield
USBAA	U.S. BAA corporate bond yield

Notes.

1. The sample period is from January 1984 to December 2004 (unless specified above).
2. The frequencies of the variables are monthly and quarterly.
3. U.S. dollar denominated Japanese indexes are obtained by dividing them by the prevailing exchange rates between the U.S. and Japan.

bond index returns for Japan and the U.S., are likely to be non-stationary on the level at the 5% significant level. On the other hand, we reject the null of unit roots for the series of the three-month Treasury bill returns of Japan and the U.S. at the 5% level of significance. One of the possible explanations for the stationarity of the Japanese short-term bill returns can be the low interest rates that prevailed in Japan for most of the latter half of the period covered in this study. All of the returns series seem to be stationary in their first difference (these results are available on request) at the 5% significant level. These results are similar to those of previous studies (e.g., DeGennaro, Kunkel and Lee, 1994; Clare, Thomas and Wikens, 1995; Smith, 2002).

Table 14.2
Descriptive Statistics

Variables	Nobs	Mean	Std. Dev.	Minimum	Maximum
NIKKEI	252	18265.87	6673.52	7699.5	38915.87
NIKKEIS	252	144.49	55.84	41.01	270.82
JP10I	252	1.213	0.557	0.282	2.213
JP10IL	252	147.11	52.65	68.20	238.46
JP3MI	228	1.114	0.278	0.472	1.729
JP3MIL	228	132.70	19.19	91.03	148.98
JP10Y	252	3.801	2.079	0.531	7.901
JPAAA	96	1.132	0.498	0.408	2.311
JPB	96	1.319	0.621	0.476	2.785
SP	252	652.75	402.74	151.19	1506.45
US10I	252	177.45	79.02	52.31	331.91
US3MI	228	166.97	49.26	87.29	244.40
US10Y	252	6.998	2.099	3.39	13.79
US3MY	252	5.006	2.213	0.86	10.65
USAAA	252	8.142	1.756	5.05	13.71
USBAA	252	9.089	1.929	6.09	15.20

Note. Statistics are calculated using monthly data.

The results of the Engle–Granger cointegration tests are given in Table 14.4.¹¹ When two variables are non-stationary, it is necessary to test the cointegration between the two variables to find whether these two variables exhibit any long run comovement. The test is based on testing the (non)stationarity of the residuals from a cointegrating regression. If there were no cointegration, there would be no long-run relationship binding the series together, so that the series could wander apart without bound. The null of no cointegration cannot be rejected in most cases for the whole sample period at the 5% (10%) significant level with the exception of quarterly Japanese 10-year government bond and the U.S. 10-year government bond returns, Nikkei stock index and Japanese 3-month government bill return index in the Japanese markets, and the long term government bond total return and yield in both U.S. and Japanese markets. The result from the Engle–Granger test for cointegration is consistent with DeGennaro, Kunkel and Lee (1994) and Clare, Thomas and Wikens (1995) in showing that international government bond return

¹¹ For the regression to be a cointegrating regression, the time series variables of interest need to be unit root nonstationary in this study. It seems, however, more reasonable to assume that they are stationary but have autoregressive roots near one. In that case, as Elliot (1998) points out, the point estimates can still be expected to be fairly precise and we can obtain more efficient cointegrating estimators than OLS because these estimators are asymptotically consistent and have smaller biases than OLS.

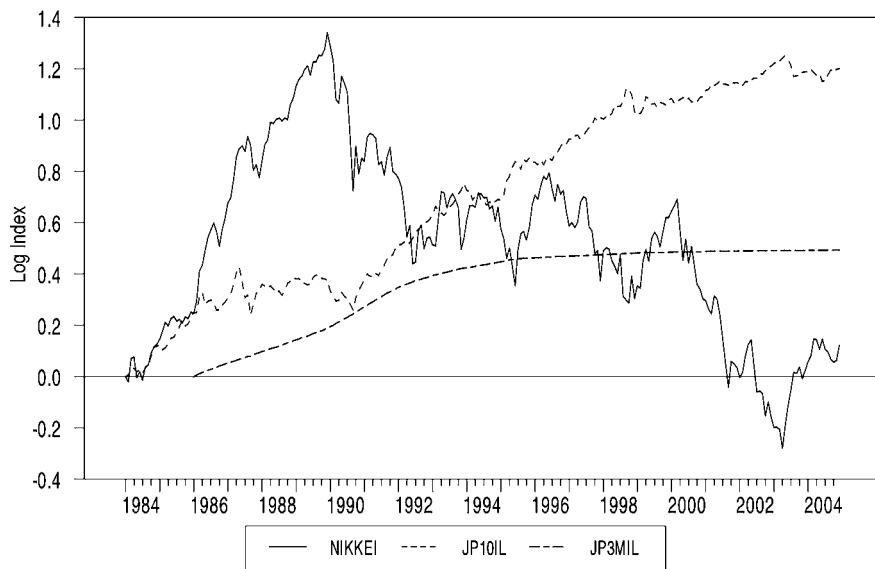


Fig. 14.1. Japan: Monthly Index Comparison, 1984–2004. NIKKEI: Nikkei 225 stock average price index. JP10IL: Japan 10 year government bond total return index. JP3MIL: Japan 3 month government bill total return index

indices are not cointegrated, but contradicts the results of Barassi, Caporale and Halls (2001) and Smith (2002).¹² As shown by Clare, Thomas and Wikens (1995), the lack of the long-run relationship may be due to the existence of many barriers to market access in international bond markets such as heterogeneous taxation and maturity structure, investment culture, and international arrangements. Furthermore, this also can be explained by a small sample bias and a lack of power of the Engle–Granger test because it is known that the Engle–Granger method suffers from a low power in a small sample and a possible simultaneous equation bias.

The CCR method is further conducted as one more robustness check because the CCR estimators have better small sample properties than the Engle–Granger test estimators. Tables 14.5 and 14.6 represent the CCR results using monthly and quarterly data, respectively. The results present a somewhat different picture. With monthly data, the deterministic cointegrating restriction is not rejected in 3 out of the 9 cases for Japanese and the U.S. pairs at the 5% significant level.

¹² The different findings on cointegration between this study and previous studies might also be due to the difference in sample periods, different sets of markets under consideration, and different proxies for bond markets.

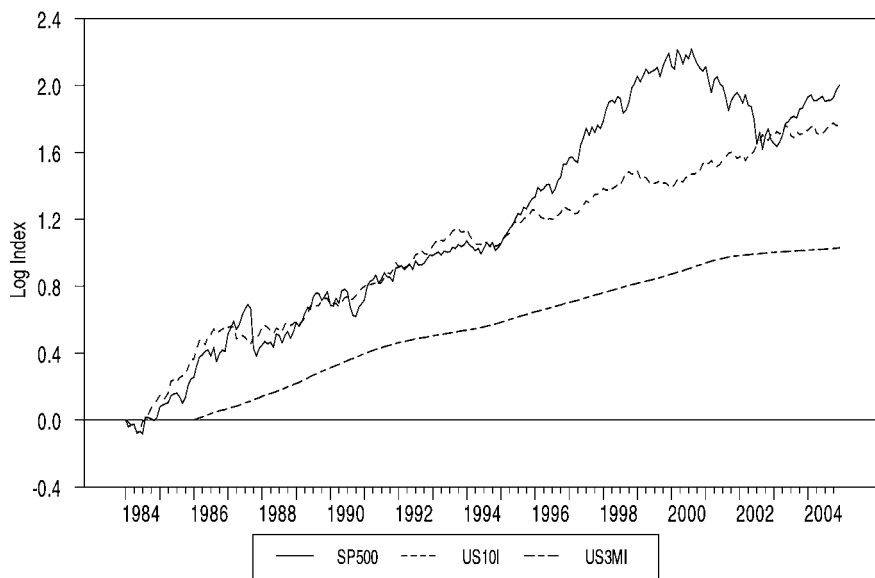


Fig. 14.2. U.S.: Monthly Index Comparison, 1984–2004. SP500: S&P 500 composite price index. US10I: U.S. 10 year government bond total return index. US3MI: U.S. 3 month government bill total return index

In the Japanese market, only the null hypothesis of deterministic cointegration is not rejected in 2 out of 4 cases, while in the U.S. market, only one out of 4 cases rejects the null hypothesis at the 5% level of significance. On the other hand, the null of stochastic cointegration is not rejected in 3 out of the 9 cases for Japanese and U.S. pairs at the 5% level. In the Japanese market, the stochastic cointegrating restriction is not rejected in 3 out of 4 cases, and the same is true for the U.S. market at the 5% level of significance.¹³

It is very interesting to see that the CCR results are more favorable with quarterly data than with monthly data. With quarterly data, the deterministic cointegrating restriction is not rejected in 5 out of 9 cases for Japanese and U.S. pairs. In the Japanese market, the null hypothesis of deterministic cointegration is not rejected in 2 out of 4 cases. Furthermore, we fail to reject the null in all cases in the U.S. market. On the other hand, the null hypothesis of stochastic cointegration is not rejected in all cases. According to this result, as shown in Mark (1995), it is likely that we have more favorable results in terms of cointegration between stock

¹³ For the terms of stochastic and deterministic cointegration, refer to Park (1990).

Table 14.3

Unit Root Tests. Augmented Dickey–Fuller [ADF] Test: $\Delta x_t = a_0 + \rho x_{t-1} + \sum_{i=1}^m \beta_i \Delta x_{t-i} + \eta_t$.
 Phillips–Perron [PP] Test: $x_t = \mu + \alpha x_{t-1} + \varepsilon_t$

Variables	Monthly		Quarterly	
	ADF	PP	ADF	PP
NIKKEI	−1.4933	−1.5026	−1.5466	−1.5656
NIKKEIS	−2.4087	−2.4184	−2.2812	−2.3092
JP10I	−2.1119	−2.1202	−1.9061	−1.9295
JP10IL	−1.3863	−1.4347	−1.2947	−1.3105
JP3MI	−3.0388**	−3.0523**	−2.6119*	−2.6475*
JP3MIL	−2.7137*	−6.7555***	−2.3163	−7.6074***
JP10Y	−1.4178	−1.2682	−1.2658	−1.2813
JPAAA	−1.4873	−1.5032	−1.6076	−1.6621
JPB	−1.4861	−1.5020	−1.7732	−1.8334
SP	−1.2698	−1.2712	−1.3901	−1.4071
US10I	−2.0013	−2.0093	−2.2105	−2.2376
US3MI	−2.9009**	−4.6639***	−1.9216	−5.9459***
US10Y	−1.7362	−1.5624	−1.8241	−1.8464
US3MY	−1.6197	−1.0999	−2.6269*	−1.4257
USAAA	−1.5627	−1.3344	−1.6799	−1.7005
USBAA	−1.5006	−1.3379	−1.6057	−1.7005

Notes.

1. The numbers in this table represent the t -statistics of the estimates of ρ and α , respectively.
2. Critical values of t -statistic with 100 (250) observations are 10%, −2.58 (−2.57); 5%, −2.89 (−2.88); and 1%, −3.51 (−3.46), respectively (Fuller, 1976, Table 8.5.2, pp. 371–373).
3. Lag (m) in the Phillips–Perron (PP) test is the number of lags included in the calculation of autocovariances of ε_t . The details of the adjusted t -statistic are referred to Phillips and Perron (1988).
4. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.
5. Log level variables are used for the unit root tests.

and bond markets in the U.S. and Japan at the longer horizon rather than at the shorter horizon data.

The results of the bivariate Granger causality tests are presented in Table 14.7. The causality model requires the determination of the appropriate lag structure in the equation. We use both AIC and SBC in conjunction with analyzing the model's residuals to select the appropriate lag structure.

The results show that there is some causal linkage between the monthly U.S. and Japanese bond markets at the 5% significant level, which is consistent with the result of the Engle–Granger causality test. That is, U.S. 10-year Treasury bond returns Granger-cause Japanese 10-year government bond returns, but not vice versa. There is a bi-directional causation between the U.S. and Japan's 10-year government bond yields in monthly basis. Nikkei stock average returns help predict future Japanese 10-year government bond returns (and yields). In the U.S.,

Table 14.4

Engle–Granger Cointegration Tests. Engle–Granger cointegration tests between y and x are performed. The bivariate spreads between y and x are represented by ε_t . If ε_t is stationary, it indicates that y and x are cointegrated. $y_t = \alpha + \beta x_t + \varepsilon_t$

Dependent Variable	Independent Variable	Monthly		Quarterly	
		ADF	PP	ADF	PP
Japan–U.S.					
NIKKEI	SP	−2.1772	−2.1859	−2.2341	−2.2615
NIKKEIS	SP	−2.2282	−2.2372	−2.1188	−2.1448
JP10I	US10I	−2.3588	−2.3682	−3.2340*	−2.4405
JP10IL	US10I	−2.3938	−2.4034	−2.5362	−2.5673
JP3MI	US3MI	−2.4715	−2.4824	−2.4348	−2.3864
JP3MIL	US3MI	−2.7211	−0.7823	−2.9729	−0.7859
JP10Y	US10Y	−2.9771	−2.9891	−3.1147*	−3.1529*
JPAAA	USAAA	−1.9411	−1.9618	−1.7557	−1.8153
JPB	USBAA	−1.7179	−1.7363	−1.9042	−1.9688
Japan					
JP10IL	NIKKEI	−3.0065	−3.0065	−2.7838	−2.8180
JP3MIL	NIKKEI	−4.3646***	−4.3839***	−3.7144**	−3.7649**
JP10IL	JP10Y	−2.5903	−2.9249	−3.0423*	−3.0797*
JP10Y	NIKKEI	−2.5666	−2.5768	−2.6307	−2.6630
U.S.					
US10I	SP	−2.0543	−2.0626	−2.2948	−2.3230
US3MI	SP	−1.7033	−1.7108	−1.8472	−1.8724
US10Y	SP	−2.5307	−2.5408	−2.9700	−3.0064
US10I	US10Y	−2.9225	−2.9343	−3.1221*	−3.1604*

Notes.

1. For the cointegration test of ε_t , critical values with 100 (200) observations are 10%, −3.03 (−3.02); 5%, −3.37 (−3.37); and 1%, −4.07 (−4.00), respectively (Engle and Yoo, 1987, Table on p. 157).
2. ε_{it} denote the residual sequences from the above long-run relationships between y and x variables.
3. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.
4. Log level variables are used for cointegration tests.
5. NIKKEIS is obtained by dividing NIKKEI by EXRATE.

the causal relation is found from quarterly 10-year government bond returns (and yields) to the S&P 500 stock returns. However, the overall results suggest the Granger causal relationships are not pronounced. One possible explanation for this is that these tests may not be efficient in dealing with small samples. Another is that Granger-causality analysis may fail to find stronger causal relationships because the appropriate time interval over which to investigate causality may be shorter than a month. If investors respond more quickly to asset returns, it may not be possible to observe Granger-causality using monthly or quarterly data. It is

Table 14.5

CCR Results (Monthly). $Y_t = \alpha + \beta X_t + \varepsilon_t$ for CCR

Dependent Variable	Independent Variable	CCR			
		$H(0, 1)$	$H(1, 2)$	$H(1, 3)$	$H(1, 4)$
Japan–U.S.					
NIKKEI	SP	0.3403 (0.5597)	1.4673 (0.2258)	8.2376 (0.0163)**	8.3312 (0.0396)**
NEKKEIS	SP	0.0002 (0.9895)	1.4972 (0.2211)	3.5724 (0.1676)	3.5834 (0.3101)
JP10I	US10I	12.7161 (0.0004)**	0.5733 (0.4489)	19.707 (0.0001)**	23.294 (0.0000)**
JP10IL	US10I	8.2392 (0.0041)**	0.0129 (0.9096)	10.912 (0.0043)**	12.637 (0.0055)**
JP3MI	US3MI	5.0485 (0.0246)**	0.0095 (0.9224)	1.7993 (0.4067)	2.5232 (0.4711)
JP3MIL	US3MI	8.3043 (0.0040)**	2.2669 (0.1322)	15.025 (0.0005)**	15.085 (0.0017)**
JP10Y	US10Y	22.984 (0.0000)**	2.2103 (0.1371)	19.265 (0.0001)**	20.973 (0.0001)**
JPAAA	USAAA	14.226 (0.0002)**	7.0309 (0.0080)**	7.1878 (0.0275)**	8.4665 (0.0373)**
JPB	USBAA	0.6922 (0.4054)	0.0500 (0.8231)	0.1981 (0.9057)	0.7829 (0.8535)
Japan					
JP10IL	NIKKEI	5.0607 (0.0245)**	0.2719 (0.6021)	11.444 (0.0033)**	13.558 (0.0036)**
JP3MIL	NIKKEI	0.0607 (0.8054)	1.7983 (0.1799)	4.6059 (0.1000)	4.6340 (0.2006)
JP10IL	JP10Y	5.7415 (0.0166)**	0.4701 (0.4929)	1.2743 (0.5288)	1.4590 (0.6918)
JP10Y	NIKKEI	1.6561 (0.1981)	0.5821 (0.4455)	0.6264 (0.7311)	0.7269 (0.8669)
U.S.					
US10I	SP	1.7031 (0.1919)	0.1120 (0.7379)	3.7938 (0.1500)	3.8158 (0.2821)
US3MI	SP	0.0417 (0.8382)	1.3256 (0.2496)	2.8215 (0.2440)	2.8264 (0.4192)
US10Y	SP	2.9164 (0.0877)	3.8382 (0.0501)**	9.2249 (0.0099)**	16.168 (0.0010)**
US10I	US10Y	4.4107 (0.0357)**	0.2059 (0.6500)	0.9367 (0.6260)	1.6139 (0.6562)

Note. Numbers in parenthesis are p -values. For instance, when p -value is less than 0.05, we reject the null hypothesis of cointegration at 5% level of significance.

** denotes significance at the 5% level.

The $H(0, 1)$ statistic tests the deterministic cointegrating restriction and the $H(1, q)$ statistic tests stochastic cointegration.

Table 14.6
 CCR Results (Quarterly). $Y_t = \alpha + \beta X_t + \varepsilon_t$ for CCR

Dependent Variable	Independent Variable	CCR			
		$H(0, 1)$	$H(1, 2)$	$H(1, 3)$	$H(1, 4)$
Japan–U.S.					
NIKKEI	SP	9.7782 (0.0018)**	1.6373 (0.2007)	6.5567 (0.0377)**	10.120 (0.0176)**
NEKKEIS	SP	0.5202 (0.4708)	0.3637 (0.5464)	0.5289 (0.7676)	0.6089 (0.8944)
JP10I	US10I	4.2238 (0.0399)**	0.2660 (0.6060)	0.4517 (0.7978)	5.7989 (0.1218)
JP10IL	US10I	0.0485 (0.8256)	0.5298 (0.4667)	0.5504 (0.7594)	1.4449 (0.6950)
JP3MI	US3MI	0.9214 (0.3371)	0.7979 (0.3717)	0.9018 (0.6370)	1.1672 (0.7609)
JP3MIL	US3MI	0.8488 (0.3569)	0.3836 (0.5357)	0.3909 (0.8225)	0.5900 (0.8987)
JP10Y	US10Y	7.2919 (0.0069)**	3.0253 (0.0820)	11.965 (0.0025)**	13.990 (0.0029)**
JPAAA	USAAA	0.4401 (0.5071)	0.0673 (0.7953)	0.0866 (0.9576)	0.0961 (0.9923)
JPB	USBAA	5.0543 (0.0246)**	2.0326 (0.1540)	2.0355 (0.3614)	2.4125 (0.4913)
Japan					
JP10IL	NIKKEI	10.716 (0.0011)**	1.3211 (0.2504)	3.4422 (0.1789)	4.7065 (0.1946)
JP3MIL	NIKKEI	8.6238 (0.0033)**	1.9346 (0.1643)	6.3415 (0.0420)**	9.5866 (0.0224)**
JP10IL	JP10Y	3.3848 (0.0658)	0.4447 (0.5049)	0.4919 (0.7820)	1.0087 (0.7991)
JP10Y	NIKKEI	0.4415 (0.5064)	0.4591 (0.4980)	0.6392 (0.7264)	0.6915 (0.8752)
U.S.					
US10I	SP	0.0093 (0.9230)	0.4818 (0.4876)	1.2095 (0.5462)	3.6459 (0.3023)
US3MI	SP	0.1607 (0.6885)	0.6901 (0.4061)	0.9952 (0.6080)	1.0619 (0.7863)
US10Y	SP	0.7939 (0.3729)	0.3475 (0.5555)	0.3767 (0.8283)	0.4507 (0.9296)
US10I	US10Y	0.8298 (0.3623)	0.4171 (0.5184)	0.4446 (0.8007)	0.5626 (0.9049)

Note. Numbers in parenthesis are p -values. For instance, when p -value is less than 0.05, we reject the null hypothesis of cointegration at 5% level of significance.

** denotes significance at the 5% level.

The $H(0, 1)$ statistic tests the deterministic cointegrating restriction and the $H(1, q)$ statistic tests stochastic cointegration.

Table 14.7

Granger Causality Tests. $\Delta y_t = a + \sum_{i=1}^m \alpha_i \Delta y_{t-i} + \sum_{i=1}^m \beta_i \Delta x_{t-i} + \varepsilon_t$, $H_0: \beta_i = 0$, for $\forall i$ (x does not Granger-cause y)

Dependent	Independent	Monthly			Quarterly		
Variable	Variable	<i>F</i> -statistic	<i>p</i> -value	$x \xrightarrow{G.C.} y$	<i>F</i> -statistics	<i>p</i> -value	$x \xrightarrow{G.C.} y$
Japan–U.S.							
NIKKEI	SP	0.3100	0.5781	No	0.1754	0.6765	No
SP	NIKKEI	0.0159	0.8995	No	0.4577	0.5007	No
JP10I	US10I	8.8098	0.005***	Yes	0.0179	0.8940	No
US10I	JP10I	0.1596	0.6899	No	0.0131	0.9091	No
JP3MI	US3MI	0.4437	0.7220	No	0.9967	0.3215	No
US3MI	JP3MI	0.0480	0.9860	No	0.0147	0.9039	No
JP10Y	US10Y	5.0158	0.0260**	Yes	0.0943	0.9596	No
US10Y	JP10Y	4.5426	0.0340**	Yes	0.7526	0.3883	No
JPAAA	USAAA	0.2867	0.5936	No	1.1973	0.2835	No
USAAA	JPAAA	1.1128	0.2943	No	0.2193	0.6433	No
JPB	USBAA	0.0150	0.9027	No	1.8725	0.1825	No
USBAA	JPB	0.7049	0.4033	No	0.1246	0.7269	No
Japan							
JP10IL	NIKKEI	9.7572	0.0019***	Yes	6.7189	0.0114***	Yes
NIKKEI	JP10IL	1.4131	0.2357	No	0.5699	0.4525	No
JP3MIL	NIKKEI	2.0359	0.1098	No	0.5449	0.4628	No
NIKKEI	JP3MIL	0.2995	0.8258	No	0.0068	0.9345	No
JP10IL	JP10Y	0.4687	0.4942	No	0.3935	0.5323	No
JP10Y	JP10IL	1.4000	0.2378	No	0.3997	0.5291	No
JP10Y	NIKKEI	12.239	0.0005***	Yes	5.3841	0.0229**	Yes
NIKKEI	JP10Y	0.6484	0.4215	No	0.0018	0.9659	No
U.S.							
US10I	SP	2.1027	0.1483	No	0.1220	0.7278	No
SP	US10I	2.4726	0.1171	No	3.6773	0.0589**	Yes
US3MI	SP	0.9175	0.4332	No	0.0942	0.7598	No
SP	US3MI	0.2353	0.8717	No	0.2048	0.6523	No
US10Y	SP	0.4849	0.4868	No	0.8363	0.3632	No
SP	US10Y	1.0866	0.2982	No	2.8234	0.0968*	Yes
US10I	US10Y	2.2012	0.1391	No	4.4759	0.0375**	Yes
US10Y	US10I	12.743	0.0004***	Yes	5.6161	0.0202**	Yes

*, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

Note. The first difference in the log level variables are used for Granger-causality tests.

“Yes (No)” indicates presence (absence) of causality with a p -value of equal or less than 0.10.

notable, however, that we still find evidence of Granger-causality using monthly and quarterly data, which suggests that monthly and quarterly time intervals may not be inappropriate for some asset categories.

5. CONCLUSIONS

The long run comovement of asset returns is a topic of considerable interest to both academicians and practitioners. Previous studies have looked into the linkages between asset markets within a country as well as across countries. In this study we test the long run comovement of stock and bond returns of Japan and the U.S. using both the Engle–Granger cointegration test and the Canonical Cointegration Regression method. The Engle–Granger cointegration tests show limited cointegration between the asset markets of the two countries, which is consistent with some of the earlier studies. But, unlike the previous studies, tests using the CCR method show evidence of comovement of asset returns of the two countries. The evidence of cointegration is especially strong when we use quarterly data. With small samples, as in this study, the CCR method is known as the better method for testing cointegration than the standard Engle–Granger method. Hence, it is reasonable to follow the results of the CCR method to draw conclusions of this study.

One of the key results of this study is the evidence of comovement between the asset returns of the two markets during the time period covered. The implication of this result is that static correlation assumptions used in many portfolio optimization models can still be valid as the asset returns are showing comovement. The second key result is that the comovement of asset returns seems to be more pronounced with the quarterly data as compared to the monthly data. As in Mark (1995), a possible explanation for this result is that while monthly asset returns tend to be dominated by noise, this noise is apparently averaged out over time. Thus systematic comovements between asset returns are likely to be more predictable with longer horizon data. Overall the results of this study can be construed as indirect evidence of the effect of cross investments leading to more integration of asset markets of the two countries.

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Chapter 15

INTERNATIONAL LINKAGES OF JAPANESE BOND MARKETS: AN EMPIRICAL ANALYSIS

Bang Nam Jeon, Philip Ji and Hongfang Zhang

Abstract

This paper examines the dynamic patterns of international linkages of the Japanese government bond yields with government bond yields in the US, the UK and Germany during the period from January 1980 to December 2004. Applying the vector autoregression (VAR) model and the vector error correction (VEC) model to monthly observations of nominal bond yields and exchange rate-adjusted bond yields over the 25-year period, this paper provides consistent empirical evidence that the Japanese bond market is independent of other major national bond markets, but it exerts some influence in determining bond yields in bond markets in other major industrial countries. However, since the early 1990, evidence shows that the independence of the Japanese bond market has increased further, while its leading role in global bond markets has been eroded significantly.

1. INTRODUCTION

As capital controls have fallen and communication technologies have advanced, world financial markets have become more closely linked in recent years. The resulting financial integration has provided a favorable environment for increasing linkages in international bond markets. However, the increasing uncertainty in global financial markets in recent years, such as the global financial market crisis of 1997–1998, divergent monetary policy across countries, and financial contagion in the global scale, has made global bond investors difficult to maintain firm views on the determinants of long-term bond yields. This new type of market uncertainty has created widely swung bond yields and divergence of bond yields

among major industrial countries in recent years. The Bank for International Settlements (BIS) reports that yield movements were particularly produced in the US and Japan, while those in the euro area were more subdued (BIS, 2004, 2005).

The bond yield curve in Japan in recent years has been characterized as low levels of interests, steep slopes between short and long maturities, and high volatility at the longer maturities. The US and European bond markets have shown similar trends. However, the Japanese long-term fixed income (for example, Japanese government bond) yield correlations with the yields either in the US and the euro area have been constantly low. To the contrary, long-term bond yields in the US and the euro area, and consequently bond yield correlations between the two regional economies, have been consistently higher despite the divergence between the US and the euro area growth prospects and key macroeconomic indicators (BIS, 2004, p. 103).

This puzzling phenomenon in international linkages among major national bond markets, divergence of the Japanese bond market from global bond markets in particular, warrants a need for more careful empirical investigation to find out, for example, whether it is a temporary or persistent long-term trend. There has been relatively little research on investigating the linkages in global bond markets, compared to extensive literature on other financial markets.¹ Sutton (2000) found excessive comovements of bond yields in major international government bond markets during 1961–1992, and ascribed it to positively correlated term premia at the long end of the term structure across national bond markets. After applying linear factor models to both currency-hedged and unhedged bond returns in the US, Germany and Japan, Driessen et al. (2003) identified the common factors, such as the world level factor and multi-country factors, that determine international bond returns, and attributed the increasing comovements among international bond returns to the existence of the common factors. Other researchers have found non-consensus evidence on the existence of long-run cointegration relationships among government bond markets in major industrial countries (Barassi, Caporale and Hall, 2001; Clare and Maras, 1995; DeGennaro, Kunkel and Lee, 1994; Smith, 2002). Applying the data-determined forecast error variance decomposition methodology, Yang (2005) showed that international bond markets are not completely segmented but instead are partially segmented and there is no distinctive leadership role by any particular national bond market during 1986–2000.

This paper examines the dynamic trends of international linkages of the Japanese bond yields with bond yields in the US, the UK and Germany during the period from January 1980 to December 2004. We analyze both the nominal bond

¹ This is especially true regarding international stock market linkages, e.g., von Furstenberg and Jeon (1989), Jeon and von Furstenberg (1990), Eun and Shim (1989), Hamao, Masulis and Ng (1990), Lee and Jeon (1995), among others.

yields and exchange rate-adjusted bond yields by applying various short-term and long-term focused time series methodologies. Applying the vector autoregression (VAR) model and the vector error correction (VEC) model to monthly observations of nominal bond yields and exchange rate-adjusted bond yields over the 25-year period, we provide consistent empirical evidence that the Japanese bond market is independent of other major national bond markets, but it exerts some influence in determining bond yields in the other major bond markets. However, since the early 1990s, evidence shows that the independence of the Japanese bond market has increased, while its role of leadership or influence in global bond markets has been eroded significantly.

The remainder of this paper is organized as follows. Section 2 describes the data used in this study. Section 3 presents empirical results. Empirical results from the subsample study are reported and discussed in Section 4. Section 5 concludes the paper.

2. DATA

In this paper we use monthly time series of long-term government bond yields, which are available from International Financial Statistics (IFS). The data cover the 25 year period from January 1980 to December 2004, including 300 monthly observations.² Our focus is on the linkage of the Japanese long-term government bond yield with those of the United States and Europe. For the European markets, we choose the United Kingdom and Germany. The data from IFS are bond yields in the domestic currency. To compare the bond yields of different countries, the exchange rate also needs to be taken into account. The data of exchange rates are also from IFS.³ Since the data from July to December of 2005 are not available at the time of writing this paper, the data for exchange rate-adjusted bond yields are up to June 2004.

² German government bonds are bonds issued by the Federal government, the railways, the postal system, the Länder government, municipalities, specific purpose public associations and other public associations established under special legislation. Bond yields are calculated as the weighted average of all bonds with an average remaining life to maturity of more than 3 years. The weights refer to the amount of individual bonds in circulation. Monthly figures are calculated as averages of four-bank-week return dates including the end-of-month yield of the preceding month. Japanese government bond yield is the arithmetic average yield to maturity of all government bonds with 7 years to maturity. Monthly series are compiled from end-of-month prices quoted on the Tokyo stock exchange. Government bond yields of the UK are theoretical gross redemption yields. Long-term government bonds are issued at par with 20 years to maturity. Long-term series of the US refer to 10-year constant maturities. Long-term government bond yields are from the IFS, line 61.ZF for each country.

³ Exchange rates are market rates, expressed by national currency per. They are from IFS line AE.ZF.

Table 15.1
Summary Statistics of Government Bond Yields (Percentage)

	Nominal bond yields		Exchange rate-adjusted bond yields	
	Average	Standard deviation	Average	Standard deviation
Panel A. Whole sample period: 1980–2004				
Japan	4.30	2.62	4.35	2.62
Germany	6.47	1.81	4.86	12.78
UK	8.59	2.95	5.22	12.98
US	7.86	2.83	5.55	13.57
Panel B. Subsample period I: 1980–1990				
Japan	6.58	1.73	6.58	1.73
Germany	7.65	1.45	4.36	12.80
UK	11.14	1.88	3.98	11.57
US	10.41	2.19	6.42	15.08
Panel C. Subsample period II: 1991–2004				
Japan	2.51	1.62	2.54	1.64
Germany	5.54	1.50	5.28	12.79
UK	6.59	1.91	6.23	13.97
US	5.86	1.17	4.85	12.20

In Table 15.1, we report the descriptive statistics of government bond yields, both nominal bond yields and exchange rate-adjusted bond yields, in Japan, Germany, the UK and the US. Japan has the lowest average return both in the nominal term and after the exchange rate adjustment is made. Before the exchange rate adjustment, Germany has the lowest standard deviation. The standard deviation of Japan is the second lowest and quite close to that of the US and the UK. When the exchange rate adjustment is made, the bond yields of Germany, the UK and the US become more volatile. It is because the relatively large fluctuations of exchange rates are incorporated in the volatility of the bond yields. When the exchange rate effect is taken into account, the bond yield of Japan is more stable than that of other countries.

The bubble economy of Japan collapsed in 1990. Figure 15.1 shows the nominal GDP and real GDP growth from 1980 to 2004. In Figure 15.1, we find that the growth rate of both nominal and real GDP starts to decline dramatically after 1990. To examine whether the linkage of government bond yields change after the change in macro-economic environment in 1990, we divide the whole sample

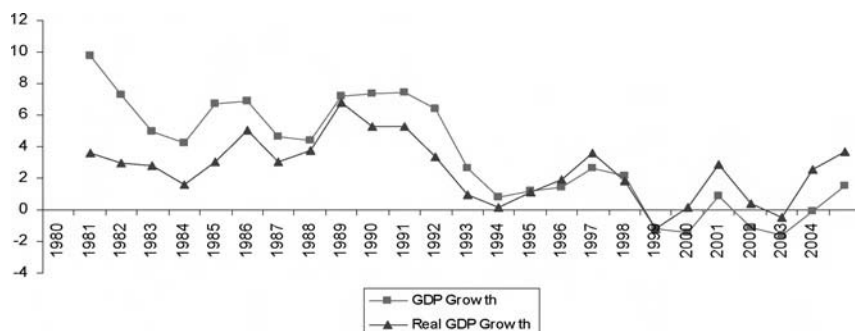


Fig. 15.1. GDP Growth in Japan (Percentage): 1980–2004

into two subsamples. The first subsample covers the period from January 1980 to December 1990 and the second subsample from January 1990 to December 2004 (June 2004 for exchange rate-adjusted bond yields).

The summary statistics of government bond yields in Japan, Germany, the UK and the US during the two subsamples are reported in Panel B and C of Table 15.1. For the first period, the average nominal bond yields are much higher than those of the exchange rate-adjusted bond yields, which means that the Japanese Yen appreciated significantly against other currencies during this period. The standard deviation of the exchange rate-adjusted bond yield is greater than that of nominal yield, which means that the volatility of the exchange rate against the Japanese Yen is much higher than that of the bond return in Germany, the UK and the US. For the second period, the difference between the nominal and exchange rate-adjusted yields becomes much smaller, implying that the Yen became stable in its value against other currencies during this period. But the nominal yields are still higher than exchange rate-adjusted yields. The volatilities of exchange rate-adjusted yields are still higher than those of nominal yields.

The average nominal government bond yields are much lower during the period after 1990 than the period before 1990, especially in Japan. However, the average exchange rate-adjusted bond yields are much higher after 1990, except in the US. The increase in the exchange rate-adjusted bond yields of Germany and the UK is caused by the depreciation of the Yen against the Euro and the UK Pound. The lower exchange rate-adjusted yields in the US after 1990 are due to the appreciated Yen against the US Dollar. After 1990, nominal yields become more volatile in Germany and the UK, and less volatile than those in Japan and the US. The exchange rate-adjusted yields of the UK become more volatile, while the exchange rate-adjusted yield of the US becomes less volatile. More volatile

exchange rate-adjusted yields of the UK come from more volatile nominal yield and exchange rate.

The exchange rate-adjusted yield of the US becomes more stable both because of the less volatile nominal bond return and because of the more stable Yen–Dollar rate. The volatility of the adjusted yield of Germany after 1990 is almost the same as that before 1990. This happens because the stable currency value of Germany reduced the volatility of the nominal yield. On the whole, the volatility of bond yields does not change much across the two periods.

3. EMPIRICAL RESULTS

As a pre-test we conducted augmented Dickey–Fuller test to examine the stationarity of each individual series. The null hypothesis is that there is one unit root. We find that there is one unit root for nominal yield at the 5% significant level. For the exchange rate-adjusted yield, there is one unit root for Japan and the UK, but no unit root for Germany and the US at the 5% significant level.

3.1. Nominal Government Bond Yields

We perform the Johansen trace test for the whole sample to see whether there is a cointegration relationship between nominal bond yields across countries. The results of the trace test, not reported here for space, indicate no cointegration relationship at the 5% significant level, providing evidence that no long-run relationship exists among the long-term government bond yields of Japan, Germany, the UK and the US.

The lack of cointegration justifies the VAR model to be used to investigate the relationship among government bond yields of the four countries in investigation. So we apply an unrestricted VAR model to the bond yield data of Japan, Germany, the UK and the US. We choose 2 lags for both nominal bond yields and exchange rate-adjusted yields after applying the Akaike information criterion for the choice of the optimal number of lags. Table 15.2 reports the result of the VAR estimation. We find that the nominal bond yield of Japan is mainly associated with the past history of its own market and the US bond market. Although the Japan bond market is relatively independent, it seems to have a significant influence on the bond market in the European area. The US market is affected little by the Japanese market.

To check whether there are causal relationships among national bond markets more systematically, we conduct the Granger causality test. The null hypothesis is that the independent variable does not Granger cause the dependent variable.

Table 15.2
VAR Model Estimation Results for Nominal Bond Yields

	Japan	Germany	UK	US
Japan_1	1.04 (16.79)***	0.19 (4.26)***	0.20 (3.35)***	0.07 (1.01)
Japan_2	-0.07 (-1.11)	-0.15 (-3.32)***	-0.16 (-2.74)***	-0.04 (-0.58)
Germany_1	0.01 (0.10)	1.11 (17.48)***	-0.01 (-0.08)	-0.20 (-1.89)*
Germany_2	-0.02 (-0.24)	-0.16 (-2.47)**	0.02 (0.21)	0.17 (1.58)
UK_1	-0.00 (0.00)	0.07 (1.47)	1.21 (18.53)***	0.03 (0.42)
UK_2	0.01 (0.22)	-0.07 (-1.5)	-0.26 (-4.00)***	-0.02 (-0.19)
US_1	0.16 (2.82)***	0.13 (3.20)***	-0.01 (-0.25)	1.32 (19.22)***
US_2	-0.15 (-2.67)***	-0.14 (-3.42)***	0.02 (0.28)	-0.36 (-5.24)***
Constant	-0.03 (-0.25)	0.20 (2.74)***	0.13 (1.28)	0.19 (1.59)

Numbers in parentheses are t-statistics. *** denotes significance at the 1% level. ** denotes significance at the 5% level. * denotes significance at the 10% level.

Table 15.3
Granger Causality Test for Nominal Bond Yields

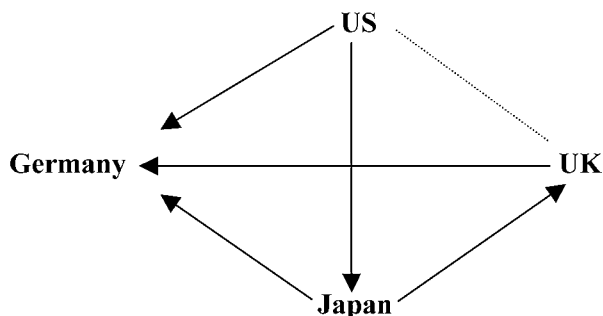
Dependent variable	Independent variable			
	Japan	Germany	UK	US
Japan	—	1.35 (0.26)	1.59 (0.21)	6.48 (0.00)
Germany	15.64 (0.00)	—	5.64 (0.00)	11.92 (0.00)
UK	7.86 (0.00)	1.13 (0.33)	—	0.61 (0.55)
US	1.21 (0.30)	1.30 (0.27)	1.09 (0.34)	—

The test statistics is F-statistics. The numbers in parentheses are *p*-values.

The result of causality test is shown in Table 15.3. The results of the causality test on nominal bond yields across countries estimates show that Japan is influenced only by the US, and it influences both Germany and the UK. The lack of causal relations from and to Japan is more precisely shown for exchange rate-adjusted bond yields. The Granger causal relationships of the four markets are visualized in Figure 15.2.

Granger causality only shows the causal relationship between the nominal bond yields. It does not measure the magnitude, the speed, nor dynamics of the influence. So we undertake variance decomposition to investigate the relative importance of Germany, the UK and the US to Japan and that of Japan to the other three markets in explaining variances of bond yields. The result of 12 month forecast error variance decomposition is provided in Table 15.4. Our result is similar to

A. Nominal bond yields



B. Exchange rate-adjusted bond yields

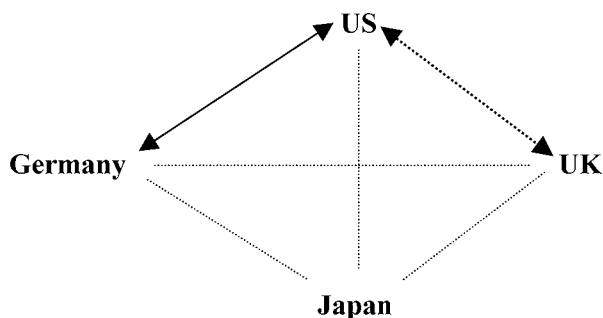


Fig. 15.2. Granger Causal Relationships between Bond Yields across Countries

that of Yang (2005), showing that Japan market seems to be relatively exogenous. Germany, the UK and the US have little impact on Japan. The US accounts for the largest proportion of the forecast error variance of Japan, which is only 3%. However, Japan can explain the significant portion of the changes of Germany (42%), the UK (26%), and the US (14%). This result is similar to that of causality tests. Japan has the lowest bond return among these four markets. Therefore, Japanese investors may invest their funds into foreign bond markets. It helps to explain why Japan has a substantial influence on the other three markets which do not affect the Japan market.

Table 15.4
Variance Decomposition of Nominal Bond Yields (Percentage)

Period	S.E.	Japan	Germany	UK	US
Variance decomposition of Japan					
1	0.28	100.00	0.00	0.00	0.00
2	0.42	98.42	0.36	0.15	1.07
3	0.52	97.02	0.52	0.39	2.07
4	0.61	96.09	0.57	0.62	2.73
8	0.85	94.33	0.50	1.53	3.65
12	1.01	93.21	0.41	2.50	3.88
Variance decomposition of Germany					
1	0.20	8.25	91.75	0.00	0.00
2	0.33	18.10	80.03	0.82	1.05
3	0.45	23.38	73.07	1.45	2.10
4	0.54	26.83	68.64	1.81	2.73
8	0.76	35.72	59.04	2.17	3.08
12	0.90	42.30	52.83	2.18	2.69
Variance decomposition of UK					
1	0.27	4.23	11.46	84.31	0.00
2	0.43	9.48	10.55	79.96	0.01
3	0.56	12.67	10.45	76.87	0.01
4	0.66	14.97	10.50	74.49	0.03
8	0.93	21.38	10.69	67.65	0.27
12	1.12	26.42	10.60	62.41	0.57
Variance decomposition of US					
1	0.33	8.74	18.48	9.08	63.70
2	0.54	9.96	14.85	10.06	65.13
3	0.70	10.44	12.91	10.70	65.96
4	0.82	10.80	11.70	11.22	66.29
8	1.12	12.43	9.22	13.13	65.22
12	1.31	14.20	7.89	14.87	63.04

To get more insight into the dynamic linkage of the Japan bond yields and the bond yields of Germany, the UK and the US, we conduct impulse response function (IRF) analysis and investigate the response of the bond yield in a country to shocks from other national markets.⁴ Figure 15.3A reports the result of the IRF analysis. In the figure, the Japanese nominal bond return is shown to be affected mainly by its own shock. Shocks from Germany, the UK and the US only have trivial influence on Japan. However, all the other three markets have significant

⁴ We applied the triangular orthogonalization of the innovation matrix with Cholesky decomposition to interpret the contemporaneous correlation matrix properly.

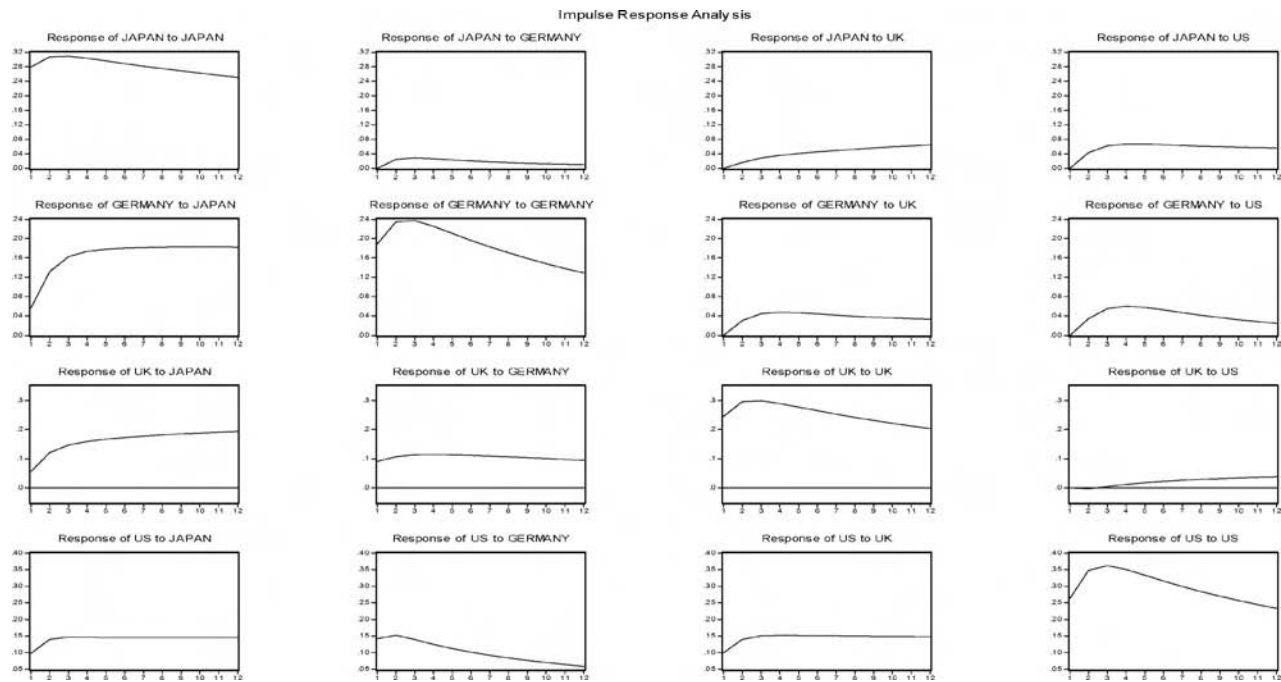


Fig. 15.3A. Impulse Response Analysis for Nominal Bond Yields: 1980–2004

responses to shocks from Japan. The response of Germany to shocks from Japan is even greater than the response to shocks from its own.

From empirical analysis of nominal government bond yields of Japan, Germany, the UK and the US, we find overall that the Japanese bond yields are quite exogenous. The Japanese bond market is mostly affected by its own market. Other foreign bond markets have little impact on the Japanese bond market. At the same time, Japan imposes a substantial and persistent influence on the bond yields in Germany, the UK, and the US.

3.2. Exchange Rate-Adjusted Government Bond Yields

We also examine the linkage of cross-country government bond yields from Japanese investors' viewpoint by using the exchange rate-adjusted bond yields, as explained in the earlier section. So we transform the data into Japanese Yen denominated bond return using the following equation:

$$i_y = i_f + \frac{e_y^e - e_y}{e_y}(1 + i_f),$$

where i_y is the unhedged bond yield in the Japanese Yen, i_f is the bond yield in other currencies, e_y is the units of the Japanese Yen per unit of foreign currency, e_y^e is the expected exchange rate of the Yen against other currencies. Here we assume that the expectation is perfect—foresight. Thus the expected exchange rate for a year horizon is the exchange rate of the same month of the next year. We derive exchange rate of the Japanese Yen against other currencies by dividing the Yen–Dollar rate by the exchange rate against the US Dollar.

Germany started to adopt the Euro in January 1999, replacing the Deutsch Mark. Accordingly, we use the units of the Japanese Yen per unit of the Euro as the exchange rate for Germany since 1999. The expected exchange rates of the Japanese Yen against the Deutsch Mark for 1999 are derived by dividing the Yen–Euro rate by the fixed exchange rate between the Deutsch Mark and the Euro (1 Euro = 1.95583 Deutsch Mark), which was set when the Euro was introduced in January 1999.

Since there is no unit root for Germany and the US, we apply the VAR model to the exchange rate-adjusted bond yields. The result is shown in Table 15.5. The exchange rate-adjusted bond yields in Japan are affected only by its own market. Only the bond yield in the UK is influenced by that in Japan. Germany and the US are not affected by Japan. Compared with the nominal bond yield case, the exchange rate-adjusted bond yields in Japan are shown to be a lot more independent. We apply the Granger causality test to exchange rate-adjusted bond yields. The

Table 15.5
VAR for Exchange Rate-Adjusted Bond Yields

	Japan	Germany	UK	US
Japan_1	1.12 (19.15)***	1.20 (1.33)	1.81 (1.89)*	1.45 (1.50)
Japan_2	-0.13 (-2.21)**	-1.29 (-1.43)	-2.01 (-2.09)**	-1.47 (-1.51)
Germany_1	0.01 (1.04)	0.95 (11.46)***	-0.15 (-1.73)*	-0.15 (-1.68)*
Germany_2	-0.01 (-1.26)	-0.02(-0.26)	0.17 (1.92)*	0.10 (1.11)
UK_1	-0.01 (-0.95)	-0.01 (-0.10)	1.06 (12.11)***	0.08 (0.89)
UK_2	0.01 (1.12)	-0.05 (-0.58)	-0.21(-2.43)**	-0.12 (-1.36)
US_1	-0.00 (-0.54)	0.12 (1.76)*	0.08 (1.06)	1.00 (13.43)***
US_2	0.00 (0.56)	-0.05 (-0.75)	0.01 (0.07)	-0.02 (-0.23)
Constant	0.03 (0.75)	0.77 (1.37)	1.23 (2.06)**	0.74 (1.22)

Numbers in parentheses are t-statistics. ***denotes significance at the 1% level. **denotes significance at the 5% level. *denotes significance at the 10% level.

Table 15.6
Granger Causality Tests for Exchange Rate-Adjusted Bond Yields

Dependent variable	Independent variable			
	Japan	Germany	UK	US
Japan	—	0.08 (0.92)	0.37 (0.69)	0.28 (0.76)
Germany	0.50 (0.61)	—	0.36 (0.70)	3.09 (0.05)
UK	1.69 (0.19)	1.11 (0.33)	—	2.59 (0.08)
US	1.22 (0.30)	4.07 (0.02)	3.02 (0.05)	—

The test statistics is F-statistics. The numbers in parentheses are *p*-values.

result is reported in Table 15.6. Japan does not Granger cause any other market, nor is it Granger caused by any other markets at the 5% significant level. These Granger causal relationships are visualized in Panel B of Figure 15.2. The line of dashed arrow denotes significant at the 10% level.

We conduct 12 month forecast error variance decomposition for the exchange rate-adjusted bond yields in the four national bond markets. As reported in Table 15.7, the forecast error of Japan is mainly explained by it own market (over 99%). The UK, the US and Germany only have a trivial influence on Japan. Unlike the nominal bond yield, the exchange rate-adjusted bond yield of Japan has very little power in explaining the forecast error of Germany, the UK, and the US.

We also use impulse response function (IRF) analysis to investigate the dynamic relationships between the exchange rate-adjusted bond yields in the national bond markets. Figure 15.3B reports the result. The Japanese bond yield is

Table 15.7
Variance Decomposition of Exchange Rate-Adjusted Bond Yields (Percentage)

Period	S.E.	Japan	Germany	UK	US
Variance decomposition of Japan					
1	0.29	100.00	0.00	0.00	0.00
2	0.43	99.72	0.00	0.23	0.05
3	0.54	99.63	0.01	0.31	0.06
4	0.62	99.64	0.00	0.30	0.06
8	0.88	99.75	0.02	0.17	0.06
12	1.05	99.69	0.08	0.17	0.06
Variance decomposition of Germany					
1	4.43	0.18	99.82	0.00	0.00
2	6.31	0.65	98.75	0.06	0.53
3	7.56	0.85	97.90	0.06	1.20
4	8.46	0.88	97.06	0.05	2.02
8	10.49	0.70	92.89	0.17	6.24
12	11.36	0.61	88.45	0.41	10.53
Variance decomposition of UK					
1	4.71	0.06	48.44	51.50	0.00
2	6.70	0.77	43.44	55.59	0.20
3	7.96	1.03	42.08	56.29	0.60
4	8.84	1.04	41.81	55.87	1.28
8	10.76	0.78	41.31	51.94	5.96
12	11.62	0.85	39.41	48.27	11.47
Variance decomposition of US					
1	4.75	0.72	24.46	10.66	64.15
2	6.63	0.37	21.10	12.92	65.62
3	7.88	0.26	18.58	13.30	67.85
4	8.82	0.21	16.56	13.12	70.11
8	11.07	0.20	11.47	11.73	76.61
12	12.18	0.26	9.77	10.77	79.19

still mainly affected by its own shocks, and shocks from Germany, the UK and the US only have a trivial influence on Japan. Although the bond yields of the UK and the US seem to respond to the shocks from Japan, but the effect is not very evident.

In summary, when exchange rate fluctuation is taken into account, our empirical investigation shows that the bond yield in Japan becomes more independent of the bond yields in the other foreign bond markets. Its influence on the other national markets is weakened significantly.

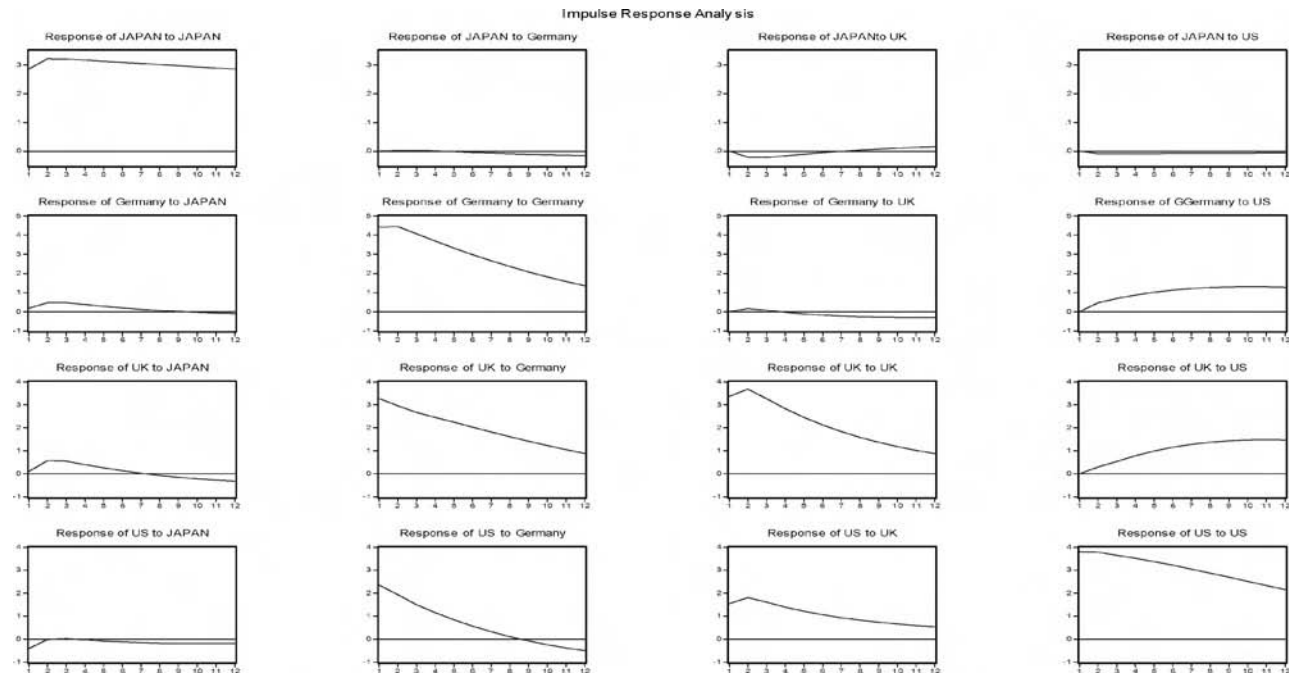


Fig. 15.3B. Impulse Response Analysis for Exchange Rate-Adjusted Bond Yields: 1980–2004

4. SUBSAMPLE STUDY: '80S VS. '90S

The Japanese economy slowed dramatically after the “bubble economy” collapsed in early 1990. To investigate whether the burst of the bubble in Japan has any impact on the linkage of Japanese bond market and government bond markets of other countries, we divide the sample into two subsamples, the period before 1990 and the period after 1990. For each sample we try to find out whether the bond yield of Japan affects those of other countries or whether it is affected by the bond yields of other countries, nominal bond yields as well as exchange rate-adjusted bond yields.

4.1. The Period before 1990

We apply unit root tests and find that there is one unit root for both nominal and exchange rate-adjusted bond yields of all the four countries at the 5% significance level. None of the series is shown to be stationary. We then use the Johansen trace test to check whether there is a long-run trend among the bond yields in the four national markets. The test statistics show that there is no cointegration for nominal bond yields at the 5% level. So there is no long-run relationship among the nominal bond yields across countries. For the exchange rate-adjusted bond yield, there is one cointegration equation at the 5% level, which indicates that there is a long-run relationship among the exchange rate-adjusted bond yields across countries.

Since there is no long-run trend among nominal bond yields, we use the VAR model to examine the pattern of interaction between the Japanese bond yields and the bond yields of Germany, the UK and the US. Panel A of Table 15.8 reports the result of the VAR analysis. The result shows that the nominal government bond yield of Japan is affected only by its own market and the US bond market during the pre-1990 collapse period. Compared with the whole sample, the impact of the US is less significant for the period of 1980–1990 (5%) than for 1980–2000 (1%). However, the Japanese bond market affects the bond yields of all other countries except the US.

We use the Granger causality test to investigate whether the bond yields of Germany, the UK and the US have an explanatory power on the bond yield of Japan. The result is shown in Table 15.9. The Japanese bond yield is not Granger caused by the bond yields of other countries at the 5% significance level, but it is Granger caused by the US bond yield at 10% level. The bond yields of Germany and the UK are Granger caused by the Japanese bond yields at the 5% level. The Granger causal relationship among the four markets is illustrated in Figure 15.4.

Table 15.8

VAR for Nominal Bond Yields for Subsample Periods: '80s vs. '90s

	Japan	Germany	UK	US
Panel A. The VAR model for 1980–1990				
Japan_1	1.00 (10.06)***	0.19 (2.89)***	0.19 (1.97)**	−0.02 (−0.17)
Japan_2	−0.08 (−0.76)	−0.17 (−2.56)**	−0.18 (−1.80)*	0.01 (0.05)
Germany_1	0.03 (0.22)	1.06 (11.52)***	0.01 (0.08)	−0.20 (−1.17)
Germany_2	0.05 (0.35)	−0.09 (−0.94)	0.06 (0.44)	0.26 (1.46)
UK_1	−0.02 (−0.23)	−0.07 (0.98)	1.17 (11.90)***	−0.08 (−0.06)
UK_2	0.01 (0.12)	−0.06 (−0.99)	−0.26 (−2.74)***	0.09 (0.73)
US_1	0.17 (2.09)**	0.17 (3.03)***	0.02 (0.25)	1.39 (13.37)***
US_2	−0.18 (−2.13)**	−0.19 (−3.37)***	−0.03 (−0.34)	−0.45 (−4.25)***
Constant	0.07 (0.35)	0.26 (1.85)*	0.36 (1.76)*	0.17 (0.66)
Panel B. The VEC model for 1991–2004				
Error correction				
term	−0.03	0.08***	0.03	0.04*
Japan	0.10	0.09	0.11	0.17**
Germany	0.05	0.21**	0.01	−0.27**
UK	−0.10	0.13	0.25**	0.36***
US	0.21**	−0.07	−0.13	0.16
Constant	−0.02	−0.02	−0.02	−0.01

Numbers in parentheses are t-statistics. *** denotes significance at the 1% level. ** denotes significance at the 5% level. *denotes significance at the 10% level.

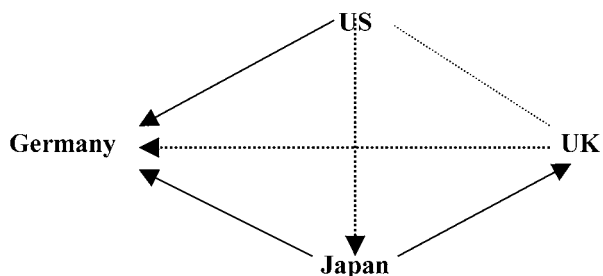
Table 15.9

Granger Causality Tests for Nominal Bond Yields for Subsample Periods: '80s vs. '90s

Dependent variable	Independent variable			
	Japan	Germany	UK	US
Panel A. 1980–1990				
Japan	—	1.70 (0.19)	0.61 (0.54)	2.91 (0.06)
Germany	6.90 (0.00)	—	3.05 (0.05)	10.7 (0.00)
UK	3.53 (0.03)	2.32 (0.10)	—	0.43 (0.65)
US	0.25 (0.78)	1.71 (0.19)	0.67 (0.52)	—
Panel B. 1991–2004				
Japan	—	0.85 (0.43)	0.23 (0.80)	2.87 (0.06)
Germany	9.08 (0.00)	—	0.28 (0.76)	2.59 (0.08)
UK	3.06 (0.05)	0.47 (0.63)	—	0.47 (0.63)
US	4.37 (0.01)	0.09 (0.91)	3.46 (0.03)	—

The test statistics is F-statistics. The numbers in parentheses are *p*-values.

A. Nominal bond yields



B. Exchange rate-adjusted bond yields

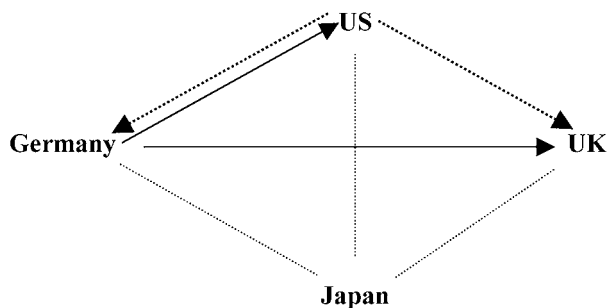


Fig. 15.4. Granger Causal Relationships between Bond Yields 1980–1990

The line of solid arrow represents the significance at the 5% level, while the line of dashed arrow represents the significance at the 10% level.

To get the relative magnitude of the influence of Japan on the other countries and that of other countries on Japan, we conduct forecast error variance decomposition. The result is shown in Table 15.10. The forecast error variance of Japan is mostly explained by itself and the explanatory power becomes smaller over time. The US has the highest explanatory power from the second to the sixth month and Germany has the highest power for the seventh to the twelfth month among the other countries. The UK has little explanatory power on Japan. Japan has significant power to explain the forecast error variance of Germany and the UK. But Japan has the lowest explanatory power on the US. This result is quite similar

Table 15.10

Variance Decomposition of Nominal Bond Yields 1980–1990 (Percentage)

Period	S.E.	Japan	Germany	UK	US
Variance decomposition of Japan					
1	0.35	100.00	0.00	0.00	0.00
2	0.51	98.09	0.44	0.14	1.33
3	0.63	96.27	0.99	0.19	2.55
4	0.72	94.93	1.64	0.20	3.24
8	0.97	91.18	5.25	0.15	3.42
12	1.14	87.72	9.48	0.11	2.68
Variance decomposition of Germany					
1	0.23	15.09	84.91	0.00	0.00
2	0.40	27.46	69.15	1.37	2.02
3	0.54	31.36	62.80	2.04	3.81
4	0.64	32.84	60.43	2.17	4.56
8	0.91	35.23	59.59	1.68	3.50
12	1.09	36.66	59.49	1.21	2.64
Variance decomposition of UK					
1	0.34	4.65	3.66	91.69	0.00
2	0.55	10.13	3.72	86.13	0.02
3	0.69	13.27	4.46	82.18	0.10
4	0.80	15.44	5.52	78.83	0.20
8	1.07	21.29	11.37	66.92	0.43
12	1.24	25.42	17.60	56.61	0.37
Variance decomposition of US					
1	0.44	11.14	14.76	12.41	61.70
2	0.72	9.77	12.02	11.32	66.88
3	0.92	8.40	11.22	10.59	69.79
4	1.07	7.55	11.19	10.22	71.04
8	1.44	6.85	13.40	10.47	69.28
12	1.65	7.60	16.53	11.06	64.81

as that of the whole sample. But the explanatory power of Japan becomes even smaller for the later period of 1991–2004, as shown in Table 15.13.

Then we investigate the dynamic pattern of innovation transmission across the countries by identifying the impact of shocks from each market on the other three national bond markets. We apply impulse response function (IRF) analysis using the VAR model. The results are not shown here to save space. The evidence shows that the Japanese bond yield is affected most by shocks from its own market. The reaction of Japan to shocks from the UK and the US is evident. The response of Japan to shocks from Germany is increasing over time. But the influence of

Table 15.11
VAR for Exchange Rate-Adjusted for Subsample Periods

Independent variable	Dependent variable			
	Japan	Germany	UK	US
Panel A. VEC model for 1980–1990				
Error correction term	−0.00	−0.69***	−0.74***	−0.46***
Japan	0.13	1.87*	2.317**	2.22*
Germany	0.01	−0.13	−0.27**	−0.15
UK	−0.01	0.11	0.32***	0.22*
US	−0.00	0.01	−0.08	−0.06
Constant	−0.02	0.23	0.14	0.11
Panel B. VAR model for 1991–2004				
Japan_1	0.97 (89.11)***	0.19 (0.78)	−0.00 (−0.01)	0.06 (0.25)
Germany_1	−0.00 (−1.12)	0.89 (20.95)***	−0.06 (−1.37)	−0.05 (−1.22)
UK_1	0.00 (0.83)	0.03 (0.59)	0.92 (15.89)***	0.01 (0.25)
US_1	−0.00 (−1.41)	0.03 (0.56)	0.07 (1.30)	0.94 (18.30)***
Constant	0.06 (1.67)	−0.17 (−0.23)	0.52 (0.65)	0.33 (0.44)

Numbers in parentheses are t-statistics. ***denotes significance at the 1% level. **denotes significance at the 5% level. *denotes significance at the 10% level.

shocks from Germany is smaller than that from Japan. The other three markets react significantly to shocks from Japan. The result for the period of 1980–1990 is consistent with that for the whole sample. Although Japanese government bond market is not affected by the other markets except the US, it can significantly influence the government bond yields in Germany, the UK and the US.

Since we find evidence that there is one cointegration equation for the four exchange rate-adjusted yields at the national bond markets, it is more appropriate to use the vector error correction (VEC) model. Panel A of Table 15.11 shows the result. For Japan, the error correction term is not significant. So there is no error correction effect. The significant coefficient of Japan in other three equations indicates that the change in the bond yield in Japan affects the bond yields in Germany, the UK and the US. The effect is positive, which means that Japanese bond yields and those of other three countries move in the same direction. Bond yields in Japan are not affected by those in any other markets. We also implement Granger causality tests to check Granger causal relationships between exchange rate-adjusted bond yields across countries. The result is shown in Panel A of Table 15.12 and Panel B of Figure 15.4. Japan does not Granger cause any other markets nor is it Granger caused by any other markets.

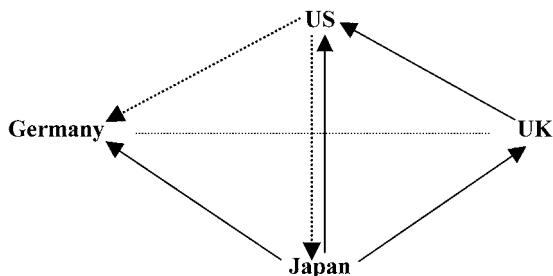


Fig. 15.5. Granger Causal Relationship between Nominal Yields 1991–2004

To get the cross-country influence of shocks on bond yields, we conduct impulse response function (IRF) analysis for the exchange rate-adjusted bond yields. The results, not reported, show that the absolute value of the response of Germany, the UK and the US to shocks from Japan exceeds that of Japan to its own shocks, which means that the shocks from Japan have more impact on the other three markets than on itself. The response of Japan to shocks from the other three markets is negligible. Shocks from the other three markets have no impact on the bond yield in Japan. This result is similar to that of the whole sample. The Japanese bond yield becomes more independent when the exchange rate effect is taken into account. The difference is that Japan still affects the other three markets, while for the whole sample Japan has no impact on the other markets when the bond yield is adjusted by the exchange rate effect.

4.2. The Period after 1990

The unit root test shows that there is one unit root for all nominal bond yields (very weak for Japan) and for exchange rate-adjusted bond yields in all the four national bond markets. The Johansen trace test shows that there are two cointegration equations for nominal bond yields and no cointegration for exchange rate-adjusted bond yields. So we implement the vector error correction (VEC) model to nominal bond yields. The result (Panel B of Table 15.8) shows that the error correction term of Japan is not significant, which suggests the lack of the error correction mechanism toward the long-run equilibrium level in the Japanese bond market during the period after 1990. The result also shows that the change in the bond yield of Japan can affect and is affected by that of the US. The Granger causality test applied to the nominal bond yield (Panel B of Table 15.9 and Figure 15.5) shows that Japan Granger causes Germany, the UK and the US at the 5% significance level, and Japan is Granger caused by the US at the 10% level.

Table 15.12

Granger Causality Test for Exchange Rate-Adjusted Bond Yields for Subsample Periods

Dependent variable	Independent variable			
	Japan	Germany	UK	US
Panel A. 1980–1990				
Japan	—	0.21 (0.81)	0.33 (0.72)	0.66 (0.52)
Germany	0.70 (0.50)	—	2.06 (0.13)	2.54 (0.08)
UK	2.28 (0.11)	3.79 (0.03)	—	2.38 (0.10)
US	1.47 (0.23)	4.12 (0.02)	5.75 (0.00)	—
Panel B. 1991–2004				
Japan	—	0.47 (0.23)	1.02 (0.36)	1.74 (0.18)
Germany	0.03 (0.97)	—	0.61 (0.54)	0.92 (0.40)
UK	0.17 (0.85)	0.90 (0.41)	—	0.76 (0.47)
US	0.03 (0.97)	1.64 (0.20)	0.64 (0.53)	—

The test statistics is F-statistics. The numbers in parentheses are *p*-values.

We also conduct impulse response function (IRF) analysis for the nominal bond yields for the post-1990 period. The results, not reported, show that the response of Japan to its own shocks is larger than those of the other three countries. The response of Japan to shocks from other countries turns out to be trivial. The reaction of other countries to shocks from Japan is quite evident. The response of Germany to shocks from Japan is even greater than to that from its own. The nominal bond yield in Japan is only influenced by that in the US after 1990, which is different from the result of the whole sample and that of the period before 1990. On the whole sample and during the period before 1990, Japan is also affected by itself. After 1990 Japan does not affect any other countries except the US. However, Germany, the UK and the US still respond to shocks from Japan, but their reactions are smaller.

Since there is no cointegration, we use the VAR model for the exchange rate-adjusted bond yields. Panel B of Table 15.11 gives the result. Japan is affected by its own market and it does not affect the other three markets either. This is quite similar to the result of the whole sample, but it is different from the results for the period before 1990. Before 1990, Japan affects the other three countries. The Granger causality test (Panel B of Table 15.12) shows that there is no Granger causal relationship among exchange rate-adjusted bond yields across countries during the period from 1991 to 2004. The 12-month forecast error variance decomposition (Table 15.13) points out that the explanatory power of Japan on the variance of the other three countries is very small. The forecast error variance of Japan is mostly explained by itself. The results of the Granger causality test and

Table 15.13

Variance Decomposition of Exchange Rate-Adjusted Bond Yields 1991–2004 (Percentage)

Period	S.E.	Japan	Germany	UK	US
Variance decomposition of Japan					
1	0.22	100.00	0.00	0.00	0.00
2	0.30	99.72	0.15	0.00	0.13
3	0.36	99.13	0.47	0.00	0.40
4	0.41	98.30	0.91	0.00	0.78
8	0.56	93.45	3.45	0.01	3.09
12	0.66	87.86	6.22	0.06	5.86
Variance decomposition of Germany					
1	4.71	4.92	95.08	0.00	0.00
2	6.45	5.02	94.89	0.07	0.02
3	7.65	5.11	94.61	0.21	0.07
4	8.56	5.19	94.24	0.43	0.14
8	10.72	5.44	92.20	1.75	0.62
12	11.76	5.58	89.76	3.38	1.28
Variance decomposition of UK					
1	4.96	1.78	53.24	44.98	0.000
2	6.77	1.65	51.62	46.62	0.11
3	8.03	1.52	50.00	48.13	0.35
4	8.98	1.41	48.40	49.51	0.68
8	11.27	1.05	42.53	53.73	2.69
12	12.44	0.87	37.95	56.16	5.01
Variance decomposition of US					
1	4.70	0.28	34.83	18.68	46.21
2	6.40	0.25	33.18	19.47	47.10
3	7.55	0.23	31.63	20.20	47.94
4	8.42	0.20	30.18	20.88	48.73
8	10.43	0.14	25.51	22.99	51.36
12	11.36	0.13	22.48	24.24	53.15

variance decomposition analysis also show that the linkage among Japan, Germany, the UK and the US government bond markets is very weak. The implement impulse response function (IRF) analysis is conducted to investigate the effects of shocks, domestic and foreign, on the exchange rate-adjusted bond yields. The results show that Japan does not react significantly to shocks from the other three countries. The reaction of other countries to shocks from Japan is also very small.

This result is quite similar to the result of the whole sample. When the exchange rate effect is taken into account, Japan becomes more independent. After 1990, the exchange rate-adjusted government bond yield of Japan does not influence those

of Germany, the UK and the US. Overall there is consistent evidence that the role of Japan in international government bond markets has been eroded further after the burst of the bubble in 1990.

5. CONCLUSION

In this paper we examined the linkage between long-term government bond yields of Japan and those of other industrialized countries—Germany, the UK and the US. We examined both nominal bond yields and exchange rate-adjusted bond yields during the period from 1980 to 2004. We find that the nominal bond yield of Japan affects those of Germany and the UK and it is influenced only by itself and that of the US. When the exchange rate effect is taken into account, the bond yield of Japan becomes more independent of those of other countries. It is not influenced by any other countries and it does not affect any other countries except the UK.

The bubble economy of Japan collapsed in 1990. After the burst of the bubble, the economic growth slowed down dramatically. To find out whether the linkage between the Japanese bond yields and those of the other three countries changed after 1990, we investigated the relationship between the bond yields of the two periods separately. This paper provides evidence that Japan's position as a major international bond market seems to have declined further in the 1990s. As is found for the whole sample, the nominal bond yield of Japan is still influenced by the US, and it affects Germany and the UK before 1990. When the exchange rate effect is added into the picture, the Japanese bond yield is not affected by the bond yield of any country. But the exchange rate-adjusted bond yield in Japan still influences the bond yields of Germany, the UK and the US. The Japanese government bond yield becomes more independent when the exchange rate effect is taken into account. After the burst of the bubble in early 1990, the nominal bond yield of Japan is only related to that of the US and the exchange rate-adjusted bond yield is not related to any other markets. The influence of Japan on the other three markets is evidenced to have been weakened significantly for both nominal and exchange rate-adjusted bond yields since 1990.

In conclusion, this paper provides consistent empirical evidence that the Japanese bond market is independent of other major national bond markets in determining its long-term bond yields, both nominal yields and exchange rate-adjusted bond yields, but it exerts some influence in determining bond yields in other major national bond markets. However, since the early 1990, the independence of the Japanese bond market has increased, while its leading role in global bond markets has been eroded significantly.

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Chapter 16

INTERNATIONAL LINKAGES OF THE JAPANESE GOVERNMENT BOND MARKET: TIME-SERIES EVIDENCE

T.J. Brailsford, Jack H. Penm and R.D. Terrell

Abstract

This paper examines the relation between the Japanese government bond market and various international counterparts. The analysis employs a new time-series approach that overcomes problems of non-stationarity and computational issues associated with many other approaches. The proposed model is simple to use, avoids cumbersome matrix inversion, and results in greater numerical accuracy. The findings reveal that movements in the Japanese (government) bond market contemporarily/instantaneously cause movements in other major government bond markets. In summary, the findings show that the Japanese (government) bond market is an influential player on the international stage. This is an important result in the context of the proposal and growing momentum for an Asian bond market based on Yen-bonds.

1. INTRODUCTION

There has been much discussion about the establishment of an Asian bond market. Much of this dialogue has been initially in response to the Asian financial crisis of 1997–98. For instance, commentators such as Tsang (1998) have argued that the lack of a strong and robust Asian bond market was a significant reason behind the financial turmoil.¹ Rhee (2004) points out that during the crisis, private

¹ Refer to “Speech to the Asian Debt Conference” given by the Hon Donald Tsang, Financial Secretary of the Hong Kong Special Administrative Region, 6 July 1998.

Table 16.1

Percentage of Total Financing of the Economy as at 2003

Region	Bank Loans %	Stock Market %	Bonds %
USA	19.5	33.2	47.2
Japan	33.7	21.9	44.4
Asia—ex-Japan	36.8	44.6	18.5

sector savings were channeled through short-term bank financing from outside the Asian region, and that if a relatively small amount of accumulated currency reserves could have been directed to the capital accounts, then the effects of the crisis would have been far different. Thus it is understandable that much of the economic and political rationale for an Asian bond market continues to centre on a desire to improve regional financial stability and advance regional integration.

As a consequence, there have been various initiatives around the implementation of an Asian bond market. These include the so-called Chiang Mai Initiative of 2000 by the ASEAN+3 finance ministers; the establishment of an Asian Cooperation Dialogue; the APEC Regional Bond Market Development Initiative; the Asian Bond Fund Initiative by the East Asia Pacific Central Banks; and perhaps the most important agreement of the Chiang Mai Declaration of June 2003. A consistent theme running through most of these initiatives is the general consensus that any such bond market would be based in Tokyo.

However, while agreement may have been reached on the general principle, there remains open many practical questions about how such a market would operate. These questions can be considered as falling into three categories.² First, there are issues around the operational and governance aspects of such a market. These include matters of the market structure, listing requirements, rules, documentation and so forth. Second, critical issues remain open about how the common market would link with domestic markets. It is widely accepted that further work is required on establishing stability, liquidity, efficiency and confidence in local bond markets before a common market could be implemented. As Table 16.1 shows, bond markets in Asia currently play only a relatively minor role in financing.

Third, there remains open the question of the currency in which the bonds should be denominated. One approach would be to leave the bonds denominated in local currencies and then package up issues in a securitized instrument denominated in a standard currency. An alternative approach could involve the adoption

² The purpose of this paper is not to discuss the relative merits and detailed specific issues as this is well covered elsewhere (e.g., Ito and Park, 2004).

of a single currency, such as the example of Yankee bonds. In this regard, the Yen emerges as a clear favourite if such a model was ultimately adopted.³

This study is concerned with providing evidence on the linkages between the Japanese (government) bond market and international counterparts to assist in further understanding the last of the above sets of issues. In order to appreciate the consequences of adopting the Yen as a form of standard currency, and specifically in relation to bond issues, we need to first understand how current Japanese bonds denominated in Yen relate to other financial markets.⁴ That is, we need to first examine evidence as to where the Japanese bond market sits in relation to global bond markets before moving to an examination of the potential influence of a Yen-denominated bond market within Asia.

The study employs a time-series framework to analyze the issue. The more traditional framework for examining these questions is through VAR. However, VAR modelling does not explicitly detect evolutionary causal changes in the current and contemporary variable structures. It only provides the relationships detected from the lagged model structure. Further, researchers are often concerned that the coefficients of their established models may not be constant over time, but vary when the models are disturbed by changes arising from outside factors. An obvious example of this occurs in financial markets such as the advent of various shocks and crises. This concern has motivated the development of sequential estimation algorithms that allow researchers to update subset time series models at consecutive time instants. This approach allows for the coefficients to slowly evolve, and reveal evolutionary changes in model structures. For instance, Hannan and Deistler (1988) propose a recursive estimation of an autoregressive (AR) model while Azimi-Sadjadi, Sheedvash and Trujillo (1993) suggest recursive updating procedure for the training process of a multi-layer neural network.

This innovation in this study is the development of an approach that utilizes vector finite lag (VFL) models incorporating a fixed forgetting factor. Such an approach has not been previously applied primarily because the commonly used estimation algorithms for full order models are not applicable, as the structure of the lag coefficients is estimated without imposing any zero restrictions. As a result, this motivates the development of evolutionary kernel-based recursions for SVFL models which includes full-order models but as a special case. In this study we focus on the fixed forgetting factor and use the exact-windowed case. Compared

³ Note that Cooper and Scholtes (2001) claim that the Japanese government is now the world's biggest debtor, with the dollar value of outstanding Japanese government bonds now greater than the stock of outstanding US Treasuries.

⁴ Lothian (1991) provides a review of the Japanese Yen for the interested reader. Note that the Yen has generally shown an upward trend reflecting its appreciation relative to the US Dollar since the onset of its float in 1971.

to the pre-windowed case proposed in Penm, Penm and Terrell (1995), the exact-windowed case utilizes only the available observations, without any assumption on unseen observations, to estimate model coefficients. We prefer evolutionary parameter updating algorithms because they allow for updated subset time-series models at consecutive time instants, and can show evolutionary changes in model structures.

The remainder of the paper is organized as follows. In Section 2 we present the background to the time-series model and explain the algorithm for recursively estimating the SVFL model. An illustration of how the proposed procedures and the model works is demonstrated in Section 3. The results from the empirical analysis involving the Japanese bond market are presented in Section 4. In Section 5, a summary and conclusions are provided.

2. DEVELOPMENT OF THE SVFL MODEL

First, note that a critical issue in any time-series model is potential non-stationarity in the series under investigation. It is now widely accepted that many financial series exhibit non-stationarity features. The forgetting factor as described in Hannan and Deistler (1988) has been previously adopted to account for non-stationarity, and it is suitable to capture non-stationarity for a model in which the underlying relationships between the variables involved change smoothly and gradually. In order to emphasize the importance of using more recent observations in modelling, the forgetting factor allocates greater weight to more recent estimated residuals and ‘forgets’ some of the past. When the recursions are implemented in the stationary situation, the value of the forgetting factor is set to one.

We now turn and consider vector finite lag (VFL) modelling. As shown in Penm, Brailsford and Terrell (2000), a VFL model has been demonstrated as a basis for constructing a multi-layered polynomial neural network. Further, Mitnik (1989) successfully applies the VFL to time series forecasting using balanced state space representations. Holmes and Hutton (1989) suggest the use of a SVFL system to assess the relationship between $y(t)$ and the set of current and lagged $x(t)$, where there is a continuous or random delay.

While there are well developed time update full-order VFL modelling algorithms (see Carayannis, Manolakis and Kalouptsidis, 1986), these are not applicable to SVFL models. This is because the ‘optimal’ subset model at time instant t may become ‘suboptimal’ at time instant $t + i$, $i = 1, \dots, n$. If one simply sets zero values to the coefficients of the missing lags, and then applies the time update algorithms for the full-order case, this leads to a loss of efficiency in the model

performance, as the subset structure of the model is not updated accordingly. Consequently, an efficient algorithm needs to be developed for the time update SVFL models, including full-order models obtained as special cases.

In SVFL modelling, it is desirable to relate $y(t)$ to present and past data for $x(t)$. We consider an SVFL model of the form:

$$y(t) + \rho + \sum_{i=1}^p d'_i(I_s)x(t+1-i) = \varepsilon^d(t) \quad \text{and} \quad d'_i(I_s) = 0, \text{ as } i \in I_s, \quad (1)$$

where $d'_i, i = 1, 2, \dots, p$, are $g \times r$ parameter matrices, ρ is an intercept variable, $\varepsilon^d(t)$ is a $g \times 1$ stationary process with $E\{\varepsilon^d(t)\} = 0$ and:

$$E\{\varepsilon^d(t)\varepsilon'^d(t-\tau)\} = \begin{cases} \Pi, & \tau = 0, \\ 0, & \tau \neq 0. \end{cases}$$

Equation (1) and properties associated with $\varepsilon^d(t)$ together constitute a VFL model, which involves a g -dimensional regressand vector $y(t)$ and an r -dimensional regressor vector $x(t)$. The order of the system is p , $1 \leq i_1 < i_2 < \dots < i_s \leq p-1$, and $x(t+1-i)$ is a deleted lag ($i \in I_s$).

Given two finite data sample sets, $\{y(n), \dots, y(T)\}$ and $\{x(n), \dots, x(T)\}$, it is necessary to sequentially estimate all possible SVFL models from (1) using the exact-windowed case. Since the actual scheme of (1) may not be order p , the resulting estimates of d_i is denoted by $d_{p,n,T}(i)$, where T is the sample size under examination. Then the predictor of an SVFL system of (1) can be described as:

$$\hat{y}(i) = -D'_{p,n,T}(I_s)X_{p-1,i}(I_s), \quad i > T, \quad (2)$$

where

$$D_{p,n,T} = [d'_{p,n,T}(1), \rho'_{p,n,T}, d'_{p,n,T}(2), \dots, d'_{p,n,T}(p)]' \quad \text{and} \\ X_{p,i} = [x(i), 1_r, \dots, x(i-p)]'.$$

1_r denotes an $r \times 1$ vector with all 1 entries. $D_{p,n,T}(I_s)$ is formed by removing $d'_{p,n,T}(i_1), \dots, d'_{p,n,T}(i_s)$ of $D_{p,n,T}$, and $X_{p,i}(I_s)$ is formed by removing $x'(i+1-i_1), \dots, x'(i+1-i_s)$ of $X_{p,i}$.

The residual vector for observation i is:

$$\varepsilon^d_{p,n,i}(I_s) = y(i) + D'_{p,n,T}(I_s)X_{p-1,i}(I_s), \quad n \leq i \leq T.$$

In reality, many time-series systems present complex non-stationary features and cannot be modeled by assuming that $y(t)$ and $x(t)$ are stationary. Thus, for a VFL model fitted to these two sample sets using the exact-windowed method of forming the sample covariance matrix, we have:

$$\begin{aligned}
 R_{p-1,n,T}(I_s)D_{p,n,T}(I_s) &= -r_{p-1,n,T}(I_s) \quad \text{where} \\
 R_{p-1,n,T}(I_s) &= \sum_{i=p-1+n}^T \lambda^{T-i} X_{p-1,i}(I_s)X'_{p-1,i}(I_s), \\
 r_{p-1,n,T}(I_s) &= \sum_{i=p-1+n}^T \lambda^{T-i} X_{p-1,i}(I_s)y'(i), \quad \text{and} \\
 \Pi_{p,T}(I_s) &= \sum_{i=p-1+n}^T \lambda^{T-i} \varepsilon_{p,n,i}^d(I_s) \varepsilon_{p,n,i}^{'d}(I_s) \quad (3)
 \end{aligned}$$

where λ , $0 < \lambda \leq 1$, is the forgetting factor as described in Hannan and Deistler (1988). The forgetting factor is suitable for a model in which the underlying relationships between the variables involved change smoothly and gradually. When $\lambda = 1$, the recursions are implemented in the stationary situation.

Further, the following relations at $t = T + 1$ have been established:

$$\begin{aligned}
 R_{p-1,n,T+1}(I_s)D_{p,n,T+1}(I_s) &= -r_{p-1,n,T+1}(I_s), \quad \text{where} \\
 R_{p-1,n,T+1}(I_s) &= \lambda R_{p-1,n,T}(I_s) + D_{p-1,n,T+1}(I_s)D'_{p-1,n,T+1}(I_s) \quad \text{and} \\
 r_{p-1,n,T+1}(I_s) &= \lambda r_{p-1,n,T}(I_s) + X_{p-1,T+1}(I_s)y(T+1). \quad (4)
 \end{aligned}$$

To develop time update recursions for SVFL modelling, we consider the forward VAR(p, I_s) model with an intercept variable of the form:

$$x(t) + \tau + \sum_{i=1}^p h_i(I_s)x(t-i) = \varepsilon(t), \quad h_i(I_s) = 0, \quad \text{as } i \in I_s \quad (5)$$

where $\varepsilon(t)$ is an independent and identically distributed random process with:

$$E\{\varepsilon(t)\} = 0, \quad E\{\varepsilon(t)\varepsilon'(t-k)\} = \begin{cases} V(I_s) & \text{if } k = 0, \\ 0, & \text{if } k \neq 0. \end{cases}$$

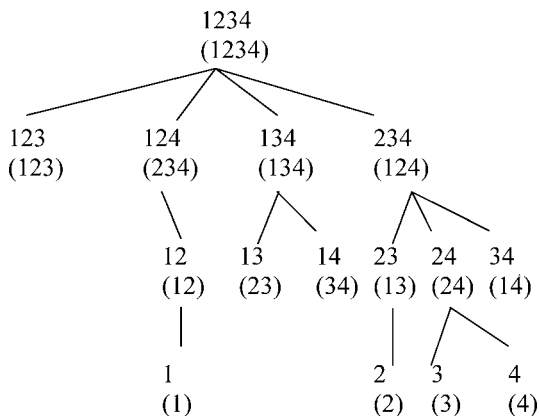


Fig. 16.1. A Four-Variable Tree Diagram to Illustrate the Reciprocal Integer Pairs of Subset VAR Models up to and Including lag Length $K = 4$. (Numerals denote particular lags in a forward VAR and numerals in parentheses denote such leads in a backward VAR.)

We also consider a backward VAR(p) model of the form:

$$g_p(M_s)x(t) + \beta + \sum_{i=0}^{p-1} g_i(M_s)x(t-p+i) = \bar{\varepsilon}(t),$$

$$g_0(M_s) = I, \quad g_i(M_s) = 0, \quad \text{as } i \in M_s, \quad (6)$$

where $E\{\bar{\varepsilon}(t)\} = 0$, and the disturbance variance is $\bar{V}(M_s)$, M_s represents an integer set with elements $m_1, m_2, \dots, m_s$, $m_j = p - i_j$, $j = 1, 2, \dots, s$.

A reciprocal integer pair for a forward subset VAR model and a backward subset VAR model is a pair of (5) and (6). Figure 16.1 shows a lag tree diagram which illustrates the reciprocal integer pairs of all subset VAR processes up to, and including, lag length $k = 4$. In this figure, numerals represent particular lags in a forward VAR and numerals in parentheses represent such leads in a backward VAR.

We need to sequentially estimate all possible subset VAR models from (5) and (6) using the exact-windowed case. Then we define observation i :

$$\underline{X}'_{p,i} = [I, x(i-1), \dots, x(i-p)],$$

$$H'_{p,n,T} = [\tau_{p,n,T}, h_{p,n,T}(1), \dots, h_{p,n,T}(p)] \quad \text{and} \quad (7)$$

$$G'_{p,n,T} = [g_{p,n,T}(p), \beta_{p,n,T}, \dots, g_{p,n,T}(1)].$$

For a reciprocal integer pair of the forward $\text{VAR}(p, I_s)$ and the backward $\text{VAR}(p, M_s)$ models fitted to this sample set, we have:

$$\begin{aligned}
 R_{p,n,T}(I_s) &= \sum_{i=p+n}^T \lambda^{T-i} X_{p,i}(O_s) X'_{p,i}(O_s), \quad \text{where} \\
 X_{p,i}(O_s) &= \left[\frac{x(i)}{\underline{X}_{p,i}(L_s)} \right] = \left[\frac{X_{p-1,i}(O_s)}{x(i-p)} \right], \\
 R_{p,n,T}(I_s) &\left[\frac{1}{H_{p,n,T}(I_s)} \right] = \left[\frac{V_{p,n,T}(I_s)}{0} \right], \\
 V_{p,n,T}(I_s) &= \sum_{t=p+n}^T \lambda^{T-i} [\varepsilon_p(t) \varepsilon'_p(t)],
 \end{aligned}$$

where O_s represents an integer set with elements o_j , $j = 1, \dots, s$, and $o_j = i_j + 2$. $X_{p,i}(O_s)$ and $X_{p-1,i}(O_s)$ are formed by removing the $(o_1), \dots, (o_s)$ th row of $X_{p,i}$ and $X_{p-1,i}$, respectively. L_s represents an integer set with elements l_j , and $l_j = i_j + 1$ and $\underline{X}_{p,i}(L_s)$ is formed by removing the $(l_1), \dots, (l_s)$ th row of $\underline{X}_{p,i}$. Also $H_{p,n,T}(I_s)$ is formed by removing $h_{p,n,T}(i_1), \dots, h_{p,n,T}(i_s)$ of $H_{p,n,T}$. Now we define:

$$\begin{aligned}
 E_{p,n,T}(I_s) &= \sum_{i=p+n}^T \lambda^{T+1-i} \underline{X}_{p,i}(L_s) \underline{X}'_{p,i}(L_s), \\
 W_{p,n,T}(I_s) &= E_{p,n,T}^{-1}(I_s) \underline{X}_{p,T+1}(L_s), \\
 \tau_{p,n,T}(I_s) &= 1 + \underline{X}'_{p,T+1}(L_s) W_{p,n,T}(I_s) \quad \text{and} \\
 e_{p,n,T+1}(I_s) &= [I | H'_{p,n,T}(I_s)] \underline{X}_{p,T+1}(L_s).
 \end{aligned} \tag{8}$$

In addition, for the corresponding backward $\text{VAR}(p, M_s)$, we have:

$$\begin{aligned}
 R_{p,n,T}(M_s) &= \sum_{i=p+n}^T \lambda^{T-i} \left[\frac{X_{p-1,i}(M_s)}{x(i-p)} \right] [X'_{p-1,i}(M_s)], \\
 \bar{V}_{p,n,T}(M_s) &= \sum_{t=n+p}^T \lambda^{T-i} [\bar{\varepsilon}_p(t) \bar{\varepsilon}'_p(t)] \quad \text{and}
 \end{aligned}$$

$$R_{p,n,T}(M_s) \left[\frac{G_{p,n,T}(M_s)}{1} \right] = \left[\frac{0}{\bar{V}_{p,n,T}(M_s)} \right],$$

where $G_{p,n,T}(M_s)$ and $X_{p-1,i}(M_s)$ are formed by removing the $(p+2-m_1), \dots, (p+2-m_s)$ th row of $G_{p,n,T}$ and $X_{p-1,i}$, respectively. We note $p+2-m_j = 2+i_j = o_j$, thus we can easily see that $X_{p-1,i}(M_s) = X_{p-1,i}(O_s)$ and $R_{p,n,T}(M_s) = R_{p,n,T}(I_s)$.

Next, we consider a forward VAR($p+1, I_s$) model with an intercept variable of the form:

$$x(t) + h_1(L_s)x(t-1) + \tau + \sum_{i=2}^{p+1} h_i(L_s)x(t-i) = \varepsilon(t), \quad h_i(L_s) = 0, \text{ as } i \in L_s,$$

where we have shifted the intercept variable to the third term of the model for ease of matrix algebra operations. Suppose the model is based on the sample set $\{x(n), x(n+1), \dots, x(T+1)\}$, we have:

$$\begin{aligned} \underline{E}_{p+1,n,T+1}(L_s) &= \sum_{i=p+1+n}^{T+1} \lambda^{T+2-i} X_{p,i-1}(O_s) X'_{p,i-1}(O_s), \\ \tilde{W}_{p+1,n,T+1}(L_s) &= \underline{E}_{p+1,n,T+1}^{-1}(L_s) X_{p,T+1}(O_s) \quad \text{and} \\ \tau_{p+1,n,T+1}(L_s) &= 1 + X'_{p,T+1}(O_s) \tilde{W}_{p+1,n,T+1}(L_s). \end{aligned} \quad (9)$$

Again we consider a forward VAR(p, L_s) model with intercept, viz:

$$x(t) + h_1(L_s)x(t-1) + \tau + \sum_{i=2}^p h_i(L_s)x(t-i) = \varepsilon(t), \quad h_i(L_s) = 0, \text{ as } i \in L_s,$$

where we keep the intercept variable in the third term to assist with our algebraic manipulations.

Suppose the model is fitted to the sample set $\{x(n+1), x(n+2), \dots, x(T+1)\}$, analogously we have:

$$\begin{aligned} \tilde{W}_{p,n+1,T+1}(L_s) &= \underline{E}_{p,n+1,T+1}^{-1}(L_s) X_{p-1,T+1}(O_s) \quad \text{and} \\ \tau_{p,n+1,T+1}(L_s) &= 1 + X'_{p-1,T+1}(O_s) \tilde{W}_{p,n+1,T+1}(L_s). \end{aligned} \quad (10)$$

The matrix inversion of $R_{p,n,T}(I_s)$ provides:

$$R_{p,n,T}^{-1}(I_s) = \begin{bmatrix} V_{p,n,T}^{-1}(I_s) & V_{p,n,T}^{-1}(I_s)H'_{p,n,T}(I_s) \\ H_{p,n,T}(I_s)V_{p,n,T}^{-1}(I_s) & E_{p,n,T}^{-1}(I_s) + H_{p,n,T}(I_s)V_{p,n,T}^{-1}(I_s)H'_{p,n,T}(I_s) \end{bmatrix}. \quad (11)$$

Right multiply with $\underline{X}_{p,T+1}(L_s)$ on both sides of (11) and employ (8) and (9), so that we have:

$$\tilde{W}_{p+1,n,T+1}(L_s) = \begin{bmatrix} 0 \\ W_{p,n,T}(I_s) \end{bmatrix} + \begin{bmatrix} I \\ H_{p,n,T}(I_s) \end{bmatrix} V_{p,n,T}^{-1}(I_s) e_{p,n,T+1}(I_s). \quad (12)$$

Again we right multiply the transpose of (12) with $\underline{X}_{p,T+1}(L_s)$, employ (8), and add 1 to both sides, so that we now establish:

$$\tau_{p+1,n,T+1}(L_s) = \tau_{p,n,T}(I_s) + e_{p,n,T+1}(I_s) V_{p,n,T}^{-1}(I_s) e'_{p,n,T+1}(I_s). \quad (13)$$

Analogously we can have:

$$\begin{aligned} \tilde{W}_{p+1,n,T+1}(L_s) &= \begin{bmatrix} \tilde{W}_{p,n+1,T+1}(L_s) \\ 0 \end{bmatrix} \\ &\quad + \begin{bmatrix} G_{p,n,T}(M_s) \\ I \end{bmatrix} \bar{V}_{p,n,T}^{-1}(M_s) \bar{e}_{p,n,T+1}(M_s), \\ \tau_{p+1,n,T+1}(L_s) &= \tau_{p,n+1,T+1}(L_s) + \bar{e}_{p,n,T+1}(M_s) \bar{V}_{p,n,T}^{-1}(M_s) \bar{e}_{p,n,T+1}(M_s), \end{aligned}$$

where

$$\bar{e}_{p,n,T+1}(M_s) = [G'_{p,n,T}(M_s) | I] X_{p,T+1}(M_s).$$

From Penm, Penm and Terrell (1995), if we permute the first row and the second row of the $\tilde{W}_{p+1,n,T+1}(I_s)$, the resulting vector is the $W_{p+1,n,T+1}(I_s)$ associated with a forward VAR($p+1, L_s$) model of the form:

$$x(t) + \delta + h_1(L_s)x(t-1) + \sum_{i=2}^{p+1} h_i(L_s)x(t-i) = \varepsilon(t), \quad a(i, L_s) = 0, \text{ as } i \in L_s,$$

which means that $W_{p+1,n,T+1}(I_s) = P_{p+1} \tilde{W}_{p+1,n,T+1}(I_s)$, where P_{p+1} is a permutation matrix of the form:

$$\begin{bmatrix} 0 & I & 0 & \dots & 0 \\ I & 0 & 0 & \dots & 0 \\ 0 & 0 & I & \dots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \dots & I \end{bmatrix}. \quad (14)$$

Note that if there is a consecutive set of k deleted lags beginning at lag 1 in the forward VAR(p, I_s) model fitted using the sample $\{x(n), \dots, x(T+1)\}$, we have:

$$W_{p,n,T+1}(I_s) = W_{p-k,n,T+1-k}(I_k) \quad \text{and} \quad \tau_{p,n,T+1}(I_s) = \tau_{p-k,n,T+1-k}(I_k), \quad (15)$$

where I_s contains $i_1, \dots, i_k, \dots, i_s$, with $i_j = j$, $j = 1, 2, \dots, k$, and I_k contains $i_{k+1}, \dots, i_{s-k}$.

We now turn to the SVFL modelling. We use (3), (4) and (8), the following time update recursions for SVFL modelling can then be developed.

$$e_{p,n,T+1}^d(I_s) = y(T+1) + D'_{p,n,T}(I_s)X_{p-1,T+1}(I_s), \quad (16)$$

$$\varepsilon_{p,n,T+1}^d(I_s) = e_{p,n,T+1}^d(I_s)\tau_{p,n,T+1}^{-1}(I_s), \quad (17)$$

$$D_{p,n,T+1}(I_s) = D_{p,n,T}(I_s) - W_{p,n,T+1}(I_s)\varepsilon_{p,n,T+1}^d(I_s), \quad (18)$$

$$\Pi_{p,T+1}(I_s) = \lambda\Pi_{p,T}(I_s) + \varepsilon_{p,n,T+1}^d(I_s)e_{p,n,T+1}^d(I_s). \quad (19)$$

In addition, the forward-time update algorithm from T to $T+1$ is summarized in Table 16.2.

3. SVFL MODELS IN PRACTICE

Assuming two sets of data, $\{x_1, x_2, \dots, x_{84}, \dots\}$ and $\{y_1, y_2, \dots, y_{84}, \dots\}$, suppose we wish to employ the above proposed forward-time update recursions for all possible SVFL models and VAR models from $(n, T) = (1, 84)$ to $(n, T) = (1, 85)$, where it is assumed that the maximum lag for VAR models and VFL models is $K = 4$. Note that we use numerals 0, 1, 2 to represent particular lags for $x(t-s)$, $s \geq 0$, and underlined numerals $\underline{1}, \underline{2}, \dots$ to represent particular leads for

Table 16.2

The Forward-Time Update Recursions from T to $T + 1$ for SVFL Forgetting-Factor Inclusive Models with Intercept Variable

$H_{p,n,T}(I_s)$, $V_{p,n,T}(I)$, $W_{p,n,T}(I_s)$, $\tau_{p,n,T}(I_s)$, $G_{p,n,T}(M_s)$, λ , $X_{p,T+1}(O_s)$, $X_{p-1,T+1}(I_s)$, $\bar{V}_{p,n,T}(M_s)$, $D_{p,n,T}(I_s)$, $\Pi_{p,T}(I_s)$, $y(T + 1)$ and $x(T + 1)$ are available	
Recursions:	
$e_{p,n,T+1}(I_s) = [1 : H'_{p,n,T}(I_s)]X_{p,T+1}(O_s)$	(20a)
$\varepsilon_{p,n,T+1}(I_s) = e_{p,n,T+1}(I_s)\tau_{p,n,T}^{-1}(I_s)$	(20b)
$H_{p,n,T+1}(I_s) = H_{p,n,T}(I_s) - W_{p,n,T}(I_s)\varepsilon'_{p,n,T+1}(I_s)$	(20c)
$V_{p,n,T+1}(I_s) = \lambda V_{p,n,T}(I_s) + \varepsilon_{p,n,T+1}(I_s)e'_{p,n,T+1}(I_s)$	(20d)
$\tilde{W}_{p+1,n,T+1}(L_s) = \begin{bmatrix} 0 \\ W_{p,n,T}(I_s) \end{bmatrix} + \begin{bmatrix} 1 \\ H_{p,n,T}(I_s) \end{bmatrix} V_{p,n,T}^{-1}(I_s)e_{p,n,T+1}(I_s)$	(20e)
partition $\tilde{W}_{p+1,n,T+1}(L_s) = \begin{bmatrix} D \\ d \end{bmatrix}$	
$\bar{e}_{p,n,T+1}(M_s) = \lambda \bar{V}_{p,n,T}(M_s)d$	(20f)
$\tilde{W}_{p,n+1,T+1}(L_s) = D - G_{p,n,T}(M_s)d$	(20g)
$\tau_{p+1,n,T+1}(L_s) = \tau_{p,n,T}(I_s) + e'_{p,n,T+1}(I_s)V_{p,n,T}^{-1}(I_s)e_{p,n,T+1}(I_s)$	(20h)
$\tau_{p,n+1,T+1}(L_s) = \tau_{p+1,n,T+1}(L_s) - \bar{e}'_{p,n,T+1}(M_s)d$	(20i)
$\bar{e}_{p,n,T+1}(M_s) = \bar{e}_{p,n,T+1}(M_s)[\tau_{p,n+1,T+1}(L_s)]^{-1}$	(20j)
$\bar{V}_{p,n,T+1}(M_s) = \lambda \bar{V}_{p,n,T}(M_s) + \bar{e}_{p,n,T+1}(M_s)\bar{e}'_{p,n,T+1}(M_s)$	(20k)
$G_{p,n,T+1}(M_s) = G_{p,n,T}(M_s) - \tilde{W}_{p,n+1,T+1}(L_s)\bar{e}'_{p,n,T+1}(M_s)$	(20l)
$W_{p,n,T+1}(I_s) = P_p \tilde{W}_{p,n,T+1}(I_s)$	(20m)
$e^d_{p,n,T+1}(I_s) = y(T + 1) + D'_{p,n,T}(I_s)X_{p-1,T+1}(I_s)$	(20n)
$\varepsilon^d_{p,n,T+1}(I_s) = e^d_{p,n,T+1}(I_s)\tau_{p,n,T+1}^{-1}(I_s)$	(20o)
$D_{p,n,T+1}(I_s) = D_{p,n,T}(I_s) - W_{p,n,T+1}(I_s)\varepsilon'^d_{p,n,T+1}(I_s)$	(20p)
$\Pi_{p,n,T+1}(I_s) = \lambda \Pi_{p,n,T}(I_s) + \varepsilon^d_{p,n,T+1}(I_s)e'^d_{p,n,T+1}(I_s)$	(20q)

$x(t + s)$, $s \geq 1$, in VAR models; and that we use italic numerals 0 , 1 , 2 to represent particular lags for $y(t - s)$, $s \geq 0$, in SVFL models.

All the $H_{p,n,T}(I_s)$, $V_{p,n,T}(I)$, $W_{p,n,T}(I_s)$, $\tau_{p,n,T}(I_s)$, $G_{p,n,T}(M_s)$, λ , $X_{p,T+1}(O_s)$, $X_{p-1,T+1}(I_s)$, $\bar{V}_{p,n,T}(M_s)$, $D_{p,n,T}(I_s)$ and $\Pi_{p,T}(I_s)$ values required are available at time $T = 84$. By employing Eqs. (20a)–(20m), we can update the matrices $H_{p,n,T}(I_s)$ and $G_{p,n,T}(M_s)$ and parameters $V_{p,n,T}(I_s)$ and $\bar{V}_{p,n,T}(M_s)$ for each reciprocal integer pair of the VAR(p , I_s) and VAR(p , M_s) at $T = 85$. Both $W_{p,n,T}(I_s)$ and $\tau_{p,n,T}(I_s)$ at $T = 85$ corresponding to the forward autoregressions that include lag 1 can also be acquired from the recursions (20e)

Fig. 16.2. Both W and τ Acquired by Using the Time Updating Approach for a VAR(4) Variable Case and the Associated SVFL Variable Case.

Panel A			
Using the recursions (20e) and (20h)			
	$T = 84$	—————→	$T = 85$
	123	—————→	1234 (<u>0123</u>)
	12	—————→	123 (<u>012</u>)
	13	—————→	124 (<u>013</u>)
	23	—————→	134 (<u>023</u>)
	1	—————→	12 (<u>01</u>)
	2	—————→	13 (<u>02</u>)
	3	—————→	14 (<u>03</u>)
	0	—————→	1 (<u>0</u>)
Panel B			
Using the relations $W_{p,n,T+1}(I_s) = W_{p-k,n,T+1-k}(I_k)$ and $\tau_{p,n,T+1}(I_s) = \tau_{p-k,n,T+1-k}(I_k)$			
	$T = 82$ $T = 83$ $T = 84$		$T = 85$
	123	—————→	234 (<u>123</u>)
	12	—————→	23 (<u>12</u>)
	13	—————→	24 (<u>13</u>)
12	—————→		34 (<u>23</u>)
	1	—————→	2 (<u>1</u>)
1	—————→		3 (<u>2</u>)
1	—————→		4 (<u>3</u>)

Notes:

Only the forward VAR of each pair has been listed.

Underline numerals denote particular lags in a SVFL whose parameters will be updated by using both W and τ acquired.

and (20h). Figure 16.2 illustrates the situation, with single lines showing the recursions. Further, by employing Eqs. (20n)–(20q), we can update the matrix, $D_{p,n,T}(I_s)$, and parameter $\Omega_{p,T}(I_s)$ for each SVFL model at $T = 85$.

Both $W_{p,n,T}(I_s)$ and $\tau_{p,n,T}(I_s)$ at $T = 85$ corresponding to the forward autoregressions that exclude lag 1 may be obtained from (15). That is, the quantities $W_{p,n,T}(I_s)$ and $\tau_{p,n,T}(I_s)$ will be identical at $T < 85$ for the forward autoregressions specified by double lines in Figure 16.2. SVFL models which parameters will be updated by using both W and τ acquired are also shown in Figure 16.2. At this point, we can carry out the forward time-update recursions from $T = 85$ to 86, $T = 86$ to 87, and so on.

To determine the optimal SVFL model at each time instant, we utilize the model selection criterion suggested by Hannan and Deistler (1988). From now on, we

will use MHQC as an abbreviation for this criterion, which is defined by:

$$\text{MHQC} = \log(\hat{\Pi}) + \frac{2 \log \log f(T)}{f(T)} N,$$

where $f(T) = \sum_{t=p-1+n}^T \lambda^{T-t}$ is the effective sample size (see Hannan and Deistler, 1988), and N the number of functionally independent parameters. The optimal model selected is the one with the minimum value of MHQC.

4. EMPIRICAL RESULTS

The data for the analysis are sourced as the J.P. Morgan monthly bond price indices (from Datastream) over the period September 1998 through June 2005. In order to remove as much default premium as possible and compare equivalent securities, we focus on long-term government bonds. While yields are not strictly comparable across national government bonds, due to differences in default premia, liquidity premia, and term structure, the data are the best available for our purposes. Moreover, we suspect that the differences in resultant yields are minor in terms of their impact on this study when averaged over securities and time.

The study involves a comparison of the Japanese government bond indices of Japan (JP) with a series of international counterparts. The key to the analysis is the causal relations from the Japanese government bond market to other government bond markets, and whether these relations have changed over time. For the purposes of this study, we undertake two experiments. First, Japan is compared to the two most significant markets of the UK and USA. These markets are chosen to proxy for a global bond market. Second, we compare Japan with a cross-selection basket of industrialized economies including Australia (AUS), Canada (CAN), Denmark (DEN) and Germany (DGR).

As a precursor to the analysis, we examine stationarity for each of the (levels) series using the augmented Dickey–Fuller (ADF) unit root test. The 95 percent critical values for each test computed using the response surface estimates, indicate that all series are $I(1)$.

For the comparison between Japanese, UK and USA government bond markets, the algorithm developed earlier is used to assess the relationships from JP to the UK–USA pair. In detecting the causal relationship from JP to UK–USA, the index change variables used are $y_1(t) = \Delta \log \text{UK}$, $y_2(t) = \Delta \log \text{USA}$, and $x_1(t) = \Delta \log \text{JP}$, where Δ denotes first difference, and the sample size of each first differenced series is 81.

Table 16.3

The SVFL for the Relationship, Linking Government Bond Indices from JP to the UK–USA Pair by MHQC Using the GLS Procedure. Variables: $y_1(t) = \Delta \log(\text{UK})$, $y_2(t) = \Delta \log(\text{USA})$, $x_1(t) = \Delta \log(\text{JP})$. SVFL: $y(t) + \rho + \sum_{\tau=1}^p d'_\tau(I_S)x(t+1-\tau) = \varepsilon^d(t)$

Non-zero i th entries in estimated coefficient matrices, d'_τ and ρ						
τ	i	$T = 76$	i	$T = 77$	i	$T = 78$
		Entry (standard error)		Entry (s.e.)		Entry (s.e.)
0	1	-.2260(.0922)	1	-.2201(.0916)	1	-.2176(.0920)
	2	-.0906(.0527)	2	-.0948(.0512)	2	-.0969(.0518)
1	1	-.1629(.0762)	1	-.1576(.0755)		
ρ	ρ_1	-.0049(.0025)	ρ_1	-.0052(.0029)	ρ_1	-.0058(.0029)
	ρ_2	-.0042(.0018)	ρ_2	-.0040(.0017)	ρ_2	-.0038(.0015)
τ	i	$T = 79$	i	$T = 80$	i	$T = 81$
		Entry (s.e.)		Entry (s.e.)		Entry (s.e.)
0	1	-.2232(.0911)	1	-.2402(.0910)	1	-.2415(.0899)
	2	-.1014(.0512)	2	-.0948(.0511)	2	-.0928(.0515)
ρ	ρ_1	-.0060(.0028)	ρ_1	-.0054(.0028)	ρ_1	-.0053(.0028)
	ρ_2	-.0041(.0018)	ρ_2	-.0043(.0016)	ρ_2	-.0044(.0016)

Note: The residual analysis confirms the vector residual series is a white noise process.

As noted earlier, any form of market integration will lead to gradual evolution in the underlying relations among financial variables. One commonly used method to deal with this issue is to break the sample into subperiods and compare the estimation results between subsamples. This method, however, is not considered effective, as no account is given to the evolution within subsamples and the difficulties associated with an arbitrary choice of the break point.

In this study, we propose to include a forgetting factor in the model. In this model an exponential forgetting is used with a forgetting factor of 0.99. To begin the process, K is set to 16 which corresponds to five quarters. The evolutionary SVFL recursions described above are then applied to the logarithms of the series to select the 'optimal' specification of the vector finite lag models. The result is a SVFL model with lags (0, 1) is selected by the MHQC at $T = 76$ and 77. In this case the predicted UK–USA output is related to the current and previous inputs of JP. Also, the lag 0 indicates instantaneous causality from JP to UK–USA. These results indicate that instantaneous and direct causal relationships exist from JP to UK–USA, even when emphasis is placed on more recent data. At $T = 78$, the lag structure selected changes to (0). From $T = 79$ to 81, the lag structure remains the same. Detailed model specifications with zero constraints selected are reported in Table 16.3.

To check the adequacy of each optimal model fit, the strategy suggested in Tiao and Tsay (1989) and Brailsford, Penm and Terrell (2001) is used, with the proposed Penm and Terrell (1984) algorithm applied to test each estimated residual vector series. The results in Table 16.3 support the hypothesis that each residual vector series is a white noise process. These optimal models are then used as the benchmark models for analyzing the causal relationships.

The analysis indicates that from $T = 76$ to 77, UK is caused by the current and lagged JP; from $T = 78$ to 81, UK is caused by the current JP only; and USA is caused by the current JP from $T = 76$ to 81. All these results occur when emphasis is placed on recent data. The findings show from $T = 78$, only contemporary/instantaneous causality detected from JP to both USA and UK.⁵

We now turn to the relation between Japan and the four selected industrialized bond markets. Table 16.4 shows the optimal finite lag models with $\lambda = 0.99$. These results strongly support the existence of current causal relationships and lagged Granger-causality from JP to each of the four markets. The results in Table 16.4 also support the hypothesis that each estimated vector residual series is a white noise process. Importantly, we find that movements of the Japanese bond market lead movements of bond markets in Australia, Canada, Germany and Denmark.⁶

Taken together, the two sets of results reveal that the Japanese bond market is influential in the international setting.

5. CONCLUSIONS

This paper has examined the relation between the Japanese government bond market and various international counterparts. The aim of the analysis was to examine whether the Japanese market was linked with comparable international market movements. However, such an analysis requires a complex time-series model to overcome problems of non-stationarity and computational issues associated with many approaches. The study develops a revolutionary recursive algorithm, using the exact-windowed case, to sequentially select the best specification for SVFL modelling. The proposed construction method is simple to use, avoids cumbersome matrix inversion, and results in greater numerical accuracy.

⁵ The causality detection from the UK–USA pair to JP is also undertaken. The results indicate that only contemporary causality exists, and no lagged causality is detected from $T = 78$. The findings show that an efficient market hypothesis does exist in this system under examination from $T = 78$. As time goes on, no arbitrage opportunity can be taken in those developed economies.

⁶ The causality detection from the bond market movements in Australia, Canada, Germany and Denmark to the movements in Japan is also undertaken. Only contemporary causality exists, and no lagged causality is detected.

Table 16.4

The SVFL for the Relationship, Linking Government Bond Indices from JP to Four EU Countries by MHQC Using the GLS Procedure. Variables: $y_1(t) = \Delta \log(\text{AUS})$, $y_2(t) = \Delta \log(\text{CAN})$, $y_3(t) = \Delta \log(\text{DGR})$, $y_4(t) = \Delta \log(\text{DEN})$, $x_1(t) = \Delta \log(\text{JP})$. SVFL: $y(t) + \rho + \sum_{\tau=1}^p d'_\tau(I_s)x(t+1-\tau) = \varepsilon^d(t)$

Non-zero i th entries in estimated coefficient matrices, d'_τ and ρ						
τ	$T = 76$		$T = 77$		$T = 78$	
	i	Entry (s.e.)	i	Entry (s.e.)	i	Entry (s.e.)
0	1	-.4042(.1108)	1	-.3990(.1105)	1	-.4052(.1101)
	2	-.1917(.0840)	2	-.1898(.0832)	2	-.1852(.0831)
	3	-.3349(.1102)	3	-.3313(.1098)	3	-.3343(.1090)
	4	-.3406(.1068)	4	-.3363(.1065)	4	-.3400(.1055)
4	1	.1607(.1005)	1	.1488(.0968)	1	.1588(.1006)
	2	.1305(.0810)	2	.1261(.0801)	2	.1185(.0781)
	3	.1685(.1012)	3	.1598(.1006)	3	.1648(.1051)
	4	.1570(.1003)	4	.1471(.0930)	4	.1531(.1001)
ρ	ρ_1	-.0080(.0035)	ρ_1	-.0085(.0033)	ρ_1	-.0080(.0031)
	ρ_2	-.0084(.0026)	ρ_2	-.0083(.0026)	ρ_2	-.0088(.0026)
	ρ_3	-.0068(.0035)	ρ_3	-.0071(.0032)	ρ_3	-.0068(.0033)
	ρ_4	-.0071(.0031)	ρ_4	-.0075(.0033)	ρ_4	-.0072(.0033)
τ	$T = 79$		$T = 80$		$T = 81$	
	i	Entry (s.e.)	i	Entry (s.e.)	i	Entry (s.e.)
0	1	-.4052(.1101)	1	-.4195(.1075)	1	-.4130(.1060)
	2	-.1852(.0831)	2	-.1619(.0830)	2	-.1455(.0830)
	3	-.3344(.1090)	3	-.3522(.1072)	3	-.3570(.1057)
	4	-.3400(.1055)	4	-.3585(.1040)	4	-.3641(.1026)
4	1	.1588(.1006)	1	.1535(.1002)	1	.1585(.1012)
	2	.1185(.0781)	2	.1259(.0801)	2	.1385(.0812)
	3	.1648(.1005)	3	.1563(.1003)	3	.1526(.1003)
	4	.1531(.1001)	4	.1443(.0901)	4	.1400(.0858)
ρ	ρ_1	-.0080(.0031)	ρ_1	-.0079(.0033)	ρ_1	-.0081(.0032)
	ρ_2	-.0088(.0026)	ρ_2	-.0085(.0025)	ρ_2	-.0092(.0025)
	ρ_3	-.0068(.0032)	ρ_3	-.0061(.0033)	ρ_3	-.0059(.0032)
	ρ_4	-.0072(.0033)	ρ_4	-.0065(.0032)	ρ_4	-.0062(.0031)

Note: The residual analysis confirms the vector residual series is a white noise process.

The findings reveal that movements in the Japanese (government) bond market exhibit instantaneous and direct causal relationships with the UK and USA (government) bond markets. Moreover, the results support the existence of current causal relationships and lagged Granger-causality from movements in the

Japanese (government) bond market to each of the four other major industrialized government bond markets studied including Australia, Canada, Denmark and Germany. In summary, the findings show that the Japanese (government) bond market is an influential player on the international stage. This is an important result in the context of the proposal for an Asian bond market. This proposal is gaining momentum but there remains much detail to be resolved. One of the key questions is the denomination of bonds in such a market. The findings in this paper that the movements in the Japanese (government) bond market contemporarily/instantaneously cause movements in other major government bond markets adds to the weight of argument that if a standard currency is adopted for the Asian market, then Yen-bonds are an appropriate candidate.

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Chapter 17

FINANCIAL MARKET INTEGRATION: EVIDENCE FROM STOCK AND BOND MARKETS IN JAPAN AND THE US

Jun Nagayasu

Abstract

We empirically examine financial market integration using stock return and bond yield data from Japan and the US. Much research has been conducted on stock market integration, but few attempts have been made to analyze the effects of bond yields on stock returns. We show that while stock markets in these countries have strongly influenced each other, less evidence is obtained of interaction between stock and bond markets in the same country, particularly in Japan. However, the bond market there has been increasingly influential over its own stock market over recent years, which is in line with recent developments in the Japanese government bond market.

1. INTRODUCTION

The government bond market has become increasingly significant in the Japanese bond market due to the recent developments and liberalization. This conspicuous expansion in the Japanese government bond (JGB) market is attributable to the poor performance of the Japanese economy, particularly after the financial and real estate bubble burst in the early 1990s. Since then, the economy went into a prolonged recession, and the government has implemented a series of expansionary fiscal policies in order to provide a Keynesian-type stimulus to revitalize the economy. As a result, government debt was about 160 percent of GDP in 2004,

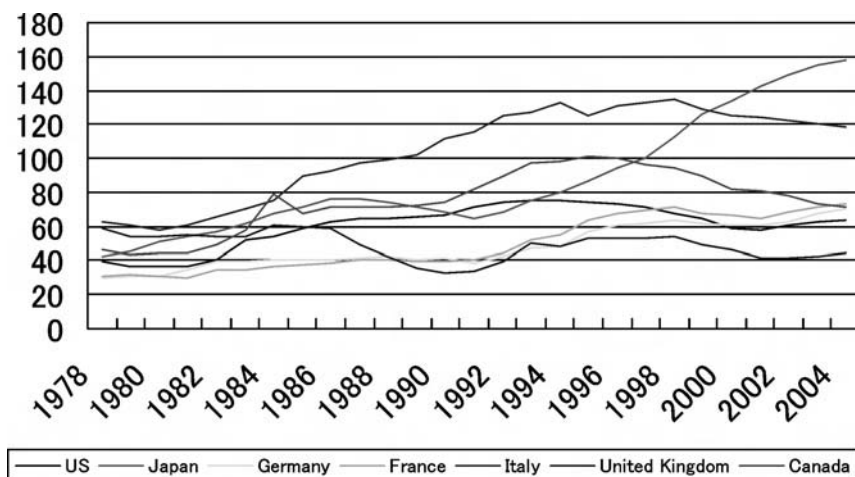


Fig. 17.1. General Government Gross Debt to GDP (%). *Note.* US debt data include the funded portion of government employee pension liabilities. Japanese data include the debt of the Japan Railway Settlement Corporation and the National Forest Special Account from 1998 onwards. German data include the debt of the Inherited Debt Fund from 1995 onwards. Source: OECD

the highest among industrialized countries, and JGBs have been used to finance the debt (see Figure 17.1).¹

The significant size of the JGB can be explained by the dramatic increase in its issuance and outstanding amounts. They came to JPY46.6 trillion and JPY225.2 trillion respectively in 1995, which soared to JPY121 trillion and JPY505 trillion in 2004 (see Figure 17.2). Even in international terms, the JGB is quite significant. In 2002, it accounted for 37% of the total gross issuance by industrialized countries, next to 44% by the US. In terms of net issuance, the JGB becomes even more significant, and easily exceeds that of other countries. The JGB made up 70% of total issuance by industrialized countries, followed by a mere 22% by the US. In terms of the amounts outstanding at the end of 2002, the JGB accounted for 35% of the total amount outstanding by industrialized countries, followed by 24% for the US.²

In addition to the developments in the JGB markets, long-term government bond yields have become an important source of information when assessing the status of the Japanese economy. Normally, both short- and long-term interest rates

¹ The history and development of the Japanese bond market is covered in, for example, Takagi (1988) and Sato and Kanovsky (1990).

² The statistics used for international comparison are based on Sumi (2005) where the original sources of the data are identified.

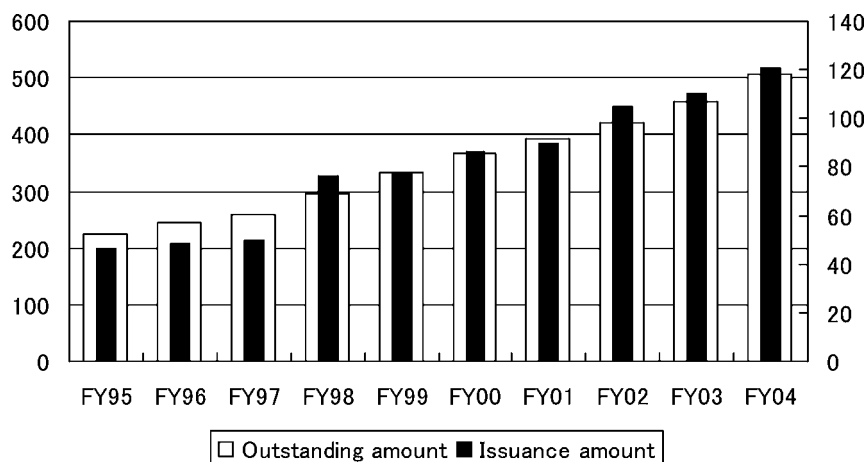


Fig. 17.2. Outstanding and Issuance Amounts of JGB (Trillion Yen). *Note.* Left-hand axis for JGB outstanding amounts, and right-hand axis for JGB issuance amounts. Source: Ministry of Finance, Japan (2005)

carry useful information about economic and financial developments. However, the Bank of Japan (BOJ) implemented an expansionary policy which led short-term interest rates to remain around the lower bound of zero percent since 1995.³ As a result, the short-term rates contain hardly any useful market information for predicting future inflation (Nagayasu, 2002). At a time when the short-term rate is facing a lower bound of zero percent and the economy experiencing deflation, an increase in long-term JGB yields triggered by expected higher inflation can be regarded as a harbinger of economic recovery at least in the short-term.

Against this enhanced JGB market, this paper examines whether the significance of government bond yields has changed in terms of influencing other segments of the financial market. More specifically, we focus primarily on the stock and bond markets in Japan and the US. Because of the recent developments, the JGB yields are expected to have affected stock returns over recent years in Japan more significantly.

This paper comprises five sections. Section 2 reviews literature that investigated the integration between stock markets across countries as well as those studies

³ The reduction in short-term interest rates reflects the aftermath of economic recession triggered by the bursting of the financial bubble. The BOJ has adopted an expansionary monetary policy since July 1991. The official discount rate was dropped to 0.5 percent in September 1995. Furthermore, a zero interest rate policy was implemented in February 1999 and a quantitative easing policy in March 2001. Both policy measures essentially have led the short-term rates to hover around zero percent.

that analyzed the interaction between stock and bond markets. Section 3 explains the data used in this paper and also shows their basic time-series properties. Section 4 briefly describes the econometric method we employed, namely, EGARCH, which has been used widely in financial research. Empirical results are reported in Sections 5 and 6, and this paper closes with the conclusion in Section 7.

2. LITERATURE REVIEW

This section reviews some empirical research on the integration of financial markets across countries with an emphasis on stock and bond markets. The recent surge in interest of researchers in this area seems to reflect developments in the financial markets of emerging economies as well as the creation of the euro zone.

2.1. Linkage between Stock Markets

Stock returns in different countries are expected to be positively correlated when these countries are open markets, since adverse effects in one country affect not only its own economy but also those of others through international trading and/or financial channels (Krugman, 1991). Thus, the more open and liberalized the economies are, the higher likely correlation between stock returns in those economies. Therefore, the correlation of stock returns has been analyzed in order to evaluate the integration of stock markets across countries.

Most research supports some degree of stock market integration. For example, Hamao, Masulis and Ng (1990) provided evidence in support of a significant correlation between stock returns in industrialized countries, and found a unidirectional causality from New York (NY) and London to Tokyo, particularly after the stock price crash of 1987. However, developments in the Tokyo market have become increasingly influential over other markets in recent years. As a result, today, unidirectional causality is rare among large financial markets such as London, NY and Tokyo (Lin, Engle and Ito, 1994; Susmel and Engle, 1994; Wei et al., 1995).

Nevertheless, clear examples of unidirectional causality have been observed more frequently from large financial markets to smaller ones. ("Small financial market" can also refer to an emerging economy.) For instance, Cotter (2004) reports the dependence of the Irish stock market on the German, UK and US markets. Wei et al. (1995) find price and volatility spillover effects from developed countries (London, NY and Tokyo) to emerging markets (Hong Kong and Tai-

wan). Furthermore, they suggest that the geographically more distant market, NY, influenced these Asian countries more than Tokyo did.⁴

In addition, the level of dependence between stock returns seems to be strengthened while the financial markets are in turmoil (Bae, Karolyi and Stulz, 2003 and Forbes and Rigobon, 2002).⁵ Forbes and Rigobon have defined contagion as a significant increase in cross-market linkages after the occurrence of a shock in other countries. Since a financial market is more volatile during a crisis and such events introduce bias in the cross-correlation coefficients, they propose making an adjustment to heteroskedasticity in the data. Then, Forbes and Rigobon found a high level of interdependence between stock returns during the 1987 US stock market crash, the 1994 Mexican devaluation, and the 1997 Asian crisis. Bae, Karolyi and Stulz do not employ the correlation measure to analyze contagion, but instead measure the joint occurrence of large movements in stock returns within and across countries, and identify a number of contagions in Asian and Latin American countries in the 1990s.

2.2. *Linkages between Bond Markets*

Compared with the global stock market research, little work has been carried out on international bond markets. This seems to be largely because of the absence of strong linkages between international bond markets. Caporale and Williams (1998) find linkages between bond yields across countries are very weak compared with relationships between short-term interest rates in developed countries. Similarly, Yang (2005) fails to obtain a co-integration relationship between government bond yields of five developed countries.

In contrast to such a long-run analysis, Sutton (2000) bases his study on a correlation measure, and observes a positive correlation in the bond yields among industrialized countries. This positive correlation may arise when short-term rates are expected to move in the same direction in these countries. Furthermore, this co-movement in the long-term bond yields is due to a common component in the term premia which cannot be explained by short-term interest rates or inflation (Sutton, 2000).

In addition, further evidence of the integration of bond markets is reported in analysis of the euro zone using recent observations. By developing indicators to

⁴ In addition, there is research focusing only on volatility spillover. For example, Jochum (1999) has shown evidence of volatility spillover from the major financial markets (Frankfurt, London, NY, and Tokyo) to the Swiss market. Kim and Rogers (1995) document volatility spillover from Tokyo and NY to Korea.

⁵ One has to be careful when reading literature on financial contagion since the definition of contagion differs by researchers.

quantify the state and evolution of financial integration, Baele et al. (2004) report that both corporate and government bond markets are highly integrated within the euro area. In particular, integration of the government bond markets has substantially increased since the introduction of the euro. Furthermore, they find that, in bond and stock markets, common news factors become increasingly important determinants, while country-specific factors become less significant. Apart from country-specific factors, they also point to the difference in credit risk attached to the bonds in different countries and the size of liquidity, when explaining the discrepancy in bond yields.⁶

In short, while the level of interaction may be sensitive to the composition of the group of countries and the sample period, these studies seem to suggest that bond markets are historically less integrated internationally than stock markets.

2.3. Linkages between Stock and Bond Markets

The theoretical relationship between stock returns and bond yields is complicated. It is often argued that a negative relationship exists between them since an increase in expected long-term government bond yields makes long-term bonds a more attractive investment choice. Therefore, investors likely shift their financial portfolio away from stocks, which contributes to a decline in stock prices. In contrast, a change in government bond yields may be positively correlated with stock return movements. This occurred in the US in October 1987 when stock prices and government bond yields decreased simultaneously. Shiller and Beltratti (1992) discuss that this simultaneous decline can be explained in the rational expectations framework. Assuming that the long-term yields contain information about an adverse prospect of corporate profits which are closely associated with future dividends, it is possible to have a positive correlation between stock prices and long-term yields when the information is significantly large.

Most empirical research focuses on the correlation between stock returns and bond yields in a single country (e.g., Shiller and Beltratti, 1992). Using UK and US data, Shiller and Beltratti (1992) confirmed a negative correlation between stock returns and changes in long-term government bond yields. However, Ehrmann, Fratzscher and Rigobon (2005) conducted a similar study by analyzing simultaneously European and US data and by including financial assets such as stock returns, government bond yields, and the exchange rate. They also assumed that a rise in long-term interest rates should lower the stock prices of that country, and have confirmed this result in the euro zone and US. Also, they find that the

⁶ Pagano and van Thadden (2004) also point to the importance of liquidity as an explanation of divergent government bond yields across countries.

level of integration has increased after the introduction of the euro, and moreover that the euro zone has become more influential over the US market.⁷

3. DATA

Data used in this paper are daily and cover the sample period from September 3, 1986 to June 1, 2005 (4891 observations). Stock data are based on Nikkei225 and S&P500 and are obtained from Finance.Yahoo.com. Given the 13 hour difference between Tokyo and NY (summer time), no overlapping trading hours exist between the Tokyo and NY markets. In order to analyze the interaction and causality of stock returns traded in these countries, intraday stock returns, the difference between closing and opening prices on date t , are used in this paper.⁸

In addition to stock data, the Yen–Dollar exchange rate (EXH) and 10-year government bond yields are obtained from the Thomson DataStream database. The JGB can be classified into (1) short-term (six-month and one-year Treasury bills), (2) medium-term (two- and five-year bonds), (3) long-term bonds (10-year bonds), (4) super long-term bonds (15-, 20-, and 30-year bonds), (5) bonds for individual investors, and (6) inflation-indexed bonds. The latter two bonds are relatively new,⁹ and since JGB market liquidity is limited with the exception of a few issues in the 5 to 10 year segment (International Monetary Fund, 2001), this paper uses the 10-year government bond yield.

One operational problem is that bond yields and the exchange rate were often found to be non-stationary, while stock returns are stationary. In order to make bond yields and the exchange rate consistent with the time-series properties of stock returns, these data are transformed into stationary ones by extracting their moving average components from the original data, as also implemented by Campbell (1991) when analyzing behaviours of stock returns.¹⁰ Since the moving average component can be viewed as the equilibrium rate, our transformed data can be interpreted as a deviation from this trend.

⁷ While this study will not focus on it, some researchers looked at volatility spillover across countries. For example, Cappiello, Engle and Sheppard (2005) analyzed volatility spillover over 21 countries, and found evidence of a structural break in correlation, not in volatility, in January 1999 when the euro was introduced. Also the correlation between European bond yields has become very close to unity since then. de Goeij and Marquering (2005) considered the volatility spillover across countries in a multivariate GARCH framework. They find evidence of conditional heteroskedasticity in the covariance between stock returns and bond yields.

⁸ Intraday data have frequently been used for such analysis (e.g., Hamao, Masulis and Ng, 1990).

⁹ JGB bonds for individual investors became available in March 2003, and inflation-indexed bonds in March 2004.

¹⁰ Whether the transformed data are stationary or not will be analyzed shortly by the unit root test.

Table 17.1
Data Descriptions

	S&P500	Nikkei225	US Yield	JP Yield	EXH
1986/09/03–2005/06/01					
Mean	0.000	−0.000	−0.003	−0.003	−0.000
Median	0.000	0.000	−0.003	−0.006	0.000
Maximum	0.087	0.124	0.673	0.729	0.063
Minimum	−0.229	−0.161	−0.765	−0.563	−0.091
SD	0.011	0.013	0.111	0.089	0.011
Skewness	−2.117	−0.177	−0.040	0.708	−0.576
Kurtosis	48.191	12.929	6.889	12.296	6.912
Normality test	419836	20114	3083	18018	3389
No. of observations	4891	4891	4891	4891	4891
1998/01/01–2005/06/01					
Mean	0.000	−0.001	−0.004	−0.002	−0.000
Median	0.000	0.000	−0.005	−0.008	0.000
Maximum	0.056	0.073	0.533	0.448	0.043
Minimum	−0.070	−0.068	−0.515	−0.303	−0.091
SD	0.012	0.012	0.115	0.063	0.011
Skewness	0.053	0.064	0.156	1.547	−0.978
Kurtosis	5.353	5.652	5.424	11.317	8.837
Normality test	446.545	568.519	481.502	6348.244	3054.805
No. of observations	1935	1935	1935	1935	1935

Note. Stock data are log intra-day returns. Government yield and exchange rate data are obtained by subtracting the moving average components (MA(1 to 10)) from the original data. Skewness coefficients equal to zero indicate a symmetric distribution ($Skewness = E[(y - \mu)^3]/\sigma^3$), and Kurtosis equal 3 is the case of the normal distribution ($Kurtosis = E[(y - \mu)^4]/\sigma^4$). The μ and σ are the mean and standard deviation of the data. The normality is examined using the Jacque–Bera test.

The time-series properties of these data are summarized in Table 17.1 and the data are plotted in Figure 17.3. Figure 17.4 plots the data that are transformed using the method described in this section, and illustrates the importance of modelling volatility in these data. In Table 17.1, all data except the Japanese government bond yield show negative skewness in the full sample indicating flat distributions for the negative values of stock returns, the US bond yield, and the exchange rate. Furthermore, the value of kurtosis well exceeds three for the normal distribution. Thus, the distribution of all data is more peaked at the center and has fatter tails. Overall, as frequently observed in high frequency financial data, the Jacque–Bera test results show that all our financial data are not normally distributed. Finally, the stationarity of these data are checked and confirmed by the Augmented Dickey–Fuller (DF) and DF-GLS unit root tests (Table 17.2).

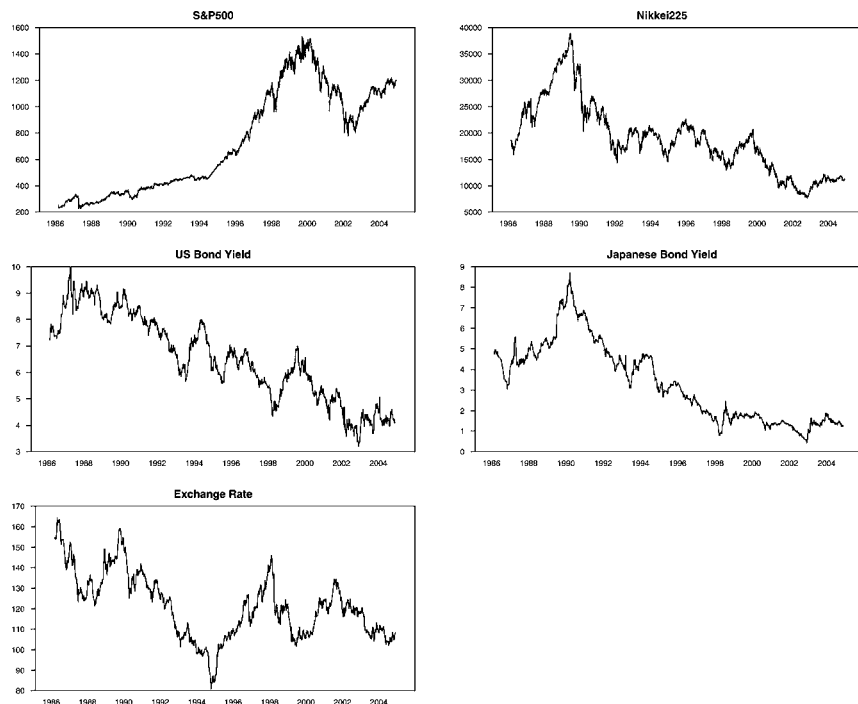


Fig. 17.3. Stock Prices, Government Bond Yields, and the Exchange Rate. *Note.* For data sources, please refer to main text. Stock prices are based on closing ones

Table 17.2
Unit Root Tests

	S&P500	Nikkei225	US Yield	JP Yield	EXH
ADF	-69.738**	-52.494**	-23.301**	-15.981**	-16.201**
DF-GLS	-12.413**	-5.978**	-12.628**	-10.921**	-14.923**

Note. The definition of the data is explained in the main text as well as Table 17.1. The Augmented Dickey–Fuller and Dickey–Fuller GLS (Elliott, Rothenberg and Stock, 1996) are used here. The test specification includes the constant term, and the appropriate lag length is determined by the Schwarz Information Criterion with a maximum of 12 lags. The asterisks, **, indicate that statistics are significant at the one percent level. The critical values are based on MacKinnon (1996). While these results are based on the full sample period, the subsample (1998/01/01–2005/06/01) also produces evidence against the null hypothesis.

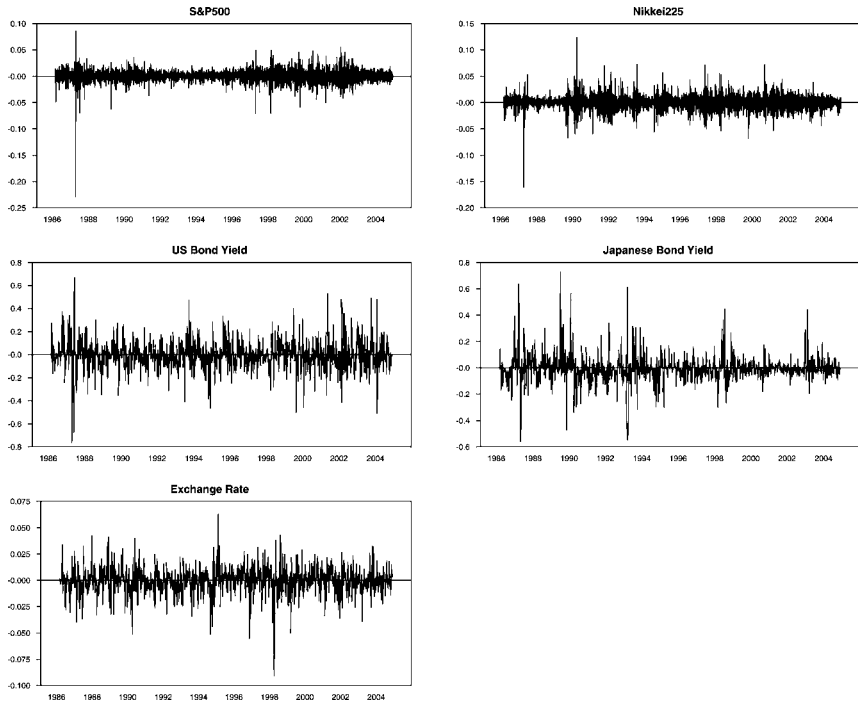


Fig. 17.4. The Stock Returns, Government Bond Yields, and the Exchange Rate. *Note.* These data are transformed from the original data. Stock returns are the difference between closing and opening prices on the same date. Bond and exchange rates are obtained by subtracting their moving components from the original series

In the following analysis, we shall study the behaviours of stock returns and government bond yields in order to take into account possible structural breaks in the data. Since the outstanding and issuance amounts of the JGB seem to have increased rapidly since 1998 (see Figure 17.2), our analysis will cover a more recent period (1998/01/01–2005/06/01) as well as the full sample period.

4. ESTIMATION METHOD

This paper employs the Exponential GARCH (EGARCH) developed by Nelson (1991) in order to model volatility which is one characteristic of high frequency financial data. Furthermore, the EGARCH has some advantages over the more standard model. First, unlike GARCH, the EGARCH does not require non-negativity

restrictions on parameters in order to ensure a positive conditional variance. Furthermore, asymmetric and magnitude effects, which are frequently observed in financial data, can be properly modelled by EGARCH.

For example, the stationary time-series, y_t , is assumed to be generated by

$$y_t = x_t' \xi + \varepsilon_t \quad (1)$$

where $t = 1, \dots, T$. In this study, y_t could be stock returns or a change in bond yields. x_t is a $k \times 1$ vector of exogenous variables and includes the constant and explanatory variables such as the stock returns, bond yields and exchange rate. ξ is a parameter vector to be estimated. The residual ε_t can be expressed as $\varepsilon_t = z_t \sqrt{h_t}$ where the conditional variance, h_t , is assumed to be formed on the basis of information available at time t and follows the EGARCH process.

$$\begin{aligned} \ln(h_t) = & \omega + \alpha |(\varepsilon_{t-1}/\sqrt{h_{t-1}}) - E(\varepsilon_{t-1}/\sqrt{h_{t-1}})| + \gamma (\varepsilon_{t-1}/\sqrt{h_{t-1}}) \\ & + \beta \ln(h_{t-1}). \end{aligned} \quad (2)$$

The logarithmic form of h_t as an endogenous variable, guarantees the nonnegative conditional variance. The presence of the asymmetric effects of the innovation on volatility (conditional variance) can be confirmed when $\gamma \neq 0$. The particular interest of investors and researchers centers on when $\gamma < 0$. In this case, a negative innovation ($\varepsilon_t < 0$, bad news) increases market volatility, while a positive innovation ($\varepsilon_t > 0$, good news) has the opposite effect. Another interesting case is when $\alpha > 0$. In this case, market volatility increases when the magnitude of $\varepsilon_{t-1}/\sqrt{h_{t-1}}$ is greater than the expected value which in turn is determined by the underlying distribution of ε_t . In this study, z_t , one element of ε_t , is assumed to follow the Generalized Error Distribution (GED) following Nelson (1991) since our data are found not to be normally distributed (Table 17.1). The above models are estimated using the maximum likelihood method.

$$L_T = \sum_{t=1}^T [\ln(\nu/\lambda) - 0.5|z_t/\lambda|^\nu - (1 + \nu^{-1}) \ln(2) - \ln[\Gamma(1/\nu)] - 0.5 \ln(h_t^2)] \quad (3)$$

where Γ is the gamma function, $\lambda \equiv [2^{(-2/\nu)} \Gamma(1/\nu) / \Gamma(3/\nu)]^{1/2}$, and $0 < \nu \leq \infty$. The GED is normally distributed if $\nu = 2$ and fat-tailed if $\nu < 2$. On the other hand, when $\nu > 2$, the distribution has thinner tails than the normal distribution. Table 17.1 indicates that our data have a fat tail and thus ν is expected to be less than two.

Table 17.3

EGARCH(1, 1) Estimates for Stock Returns and Government Bond Yields

	S&P500	Nikkei225	US Yield	JP Yield
1986/09/03–2005/06/01				
Mean equation				
<i>Const</i>	0.000 [0.000]*	−9.4E−7 [0.000]	−0.011 [0.001]**	−0.010 [0.000]**
Variance equation				
ω	−0.945 [0.003]**	−4.288 [0.405]**	−2.421 [0.127]**	−1.861 [0.092]**
α	0.018 [0.002]**	0.410 [0.037]**	0.881 [0.055]**	0.806 [0.041]**
γ	0.016 [0.003]**	−0.181 [0.026]**	0.093 [0.034]**	0.062 [0.026]*
β	0.900 [0.000]**	0.551 [0.045]**	0.634 [0.021]**	0.771 [0.014]**
ν	1.940 [0.009]**	1.028 [0.023]**	1.218 [0.020]**	1.054 [0.016]**
1998/01/01–2005/06/01				
Mean equation				
<i>Const</i>	0.000 [0.000]	−0.000 [0.000]	−0.011 [0.001]**	−0.010 [0.001]**
Variance equation				
ω	−0.206 [0.038]**	−0.315 [0.094]**	−2.250 [0.210]**	−1.836 [0.125]**
α	0.080 [0.017]**	0.134 [0.026]**	0.889 [0.092]**	0.777 [0.059]**
γ	−0.112 [0.011]**	−0.044 [0.018]**	0.078 [0.048]	0.086 [0.036]*
β	0.984 [0.004]**	0.976 [0.009]**	0.670 [0.035]**	0.797 [0.017]**
ν	1.580 [0.064]**	1.210 [0.046]**	1.362 [0.037]**	1.163 [0.030]**

Note. Stock data are log intra-day returns. Government yield data are ones obtained by subtracting the moving average component (MA(1 to 10)) from the original data. Statistics with asterisks, ** (*), are significant at the one (five) percent level. Statistics in brackets are standard errors.

Prior to a formal analysis of the interaction between the data, we initially model each data by the EGARCH only with the constant term. The results are reported in Table 17.3. While two sample periods are analyzed, the results do not seem very sensitive to the sample period. Notably, stock returns show strong signs of asymmetry ($\gamma \neq 0$) and on several occasions, $\gamma < 0$. Thus, our results suggest that while evidence exists of bad news amplifying stock volatility, there are instances where good news also increased stock volatility. Furthermore, evidence of magnitude effects ($\alpha > 0$) is found in all the data, indicating that when actual innovation is greater than expected, there is an increase in volatility. Finally, the term, ν , is statistically significant and is less than two for all cases, confirming that the standardized residuals are indeed fat-tailed. Overall, the EGARCH seems well suited to modelling these financial data.

5. STOCK MARKET INTEGRATION

Next, we shall analyze the integration of stock markets across countries. For this purpose, the stock return equations are individually estimated by the EGARCH for both countries and comprise explanatory variables such as the stock return of the other country, bond yields of both countries, and the exchange rate. Thus, Eq. (1) can be written more specifically as follows:

$$y_t = \xi_0 + \xi_1 y_t^* + \xi_2 b_t + \xi_0 b_t^* + \xi_0 s_t + \varepsilon_t \quad (4)$$

where y_t is the stock return, b_t the government bond yield, and s_t the exchange rate. The asterisk indicates the variables for a foreign country. While our analysis in this section is based on Eq. (4), a slight modification has been made only to the Nikkei equation. In this case, the lagged, not contemporaneous, US variables are included in (4) since the US market is not yet open while investors in Japan are trading and US information for date t is not available for Japanese investors on date t .

The results from the EGARCH are reported in Table 17.4. Generally, we find that the stock and bond markets in the US are historically more closely associated with each other than when compared with the Japanese markets. However, the detailed conclusion is sensitive to the sample period, which reflects the recent economic and financial developments in both countries.

Looking at our results more closely, we find that, as in previous studies (see Section 2), the stock return of one country is positively and highly correlated with the stock return in the other country. In other words, the Nikkei225 and S&P500 stock returns affect each other and tend to move in the same direction. Non-existence of unidirectional causality means that the US stock market is equally very influential over the Japanese market.¹¹ This result confirms that Japanese and US markets are liberalized and open to each other, and is consistent with previous studies (e.g., Lin, Engle and Ito, 1994; Wei et al., 1995) which suggest that it is increasingly difficult to find a unidirectional causality among industrialized countries using more recent data. Although the total capitalization of the Japanese stock market appears to diminish after the bubble burst in the early 1990s, this result is not sensitive to the sample period, and it seems that the Japanese market remains very influential over the US stock market.

One area of contrast between these two stock markets is the significance of government bond yields as an explanatory variable for stock returns. While the S&P500 return is a negative and significant function of the US government bond

¹¹ Fama (1991) points out that the existence of explanatory variables in the stock return equation itself is evidence against market inefficiency.

Table 17.4
Stock Return Equations

	1986/09/03–2005/06/01	1998/01/01–2005/06/01
S&P500		
Mean equation		
<i>Const</i>	0.000 [0.000]**	6.13E–05 [0.000]
<i>Nikkei225</i>	0.054 [0.008]**	0.117 [0.018]**
<i>US Yield</i>	–0.004 [0.001]**	0.002 [0.002]
<i>JP Yield</i>	–0.003 [0.001]	0.006 [0.003]
<i>EXH</i>	–0.000 [0.008]	–0.004 [0.018]
Variance equation		
ω	–0.216 [0.025]**	–0.214 [0.041]**
α	0.112 [0.012]**	0.090 [0.019]**
γ	–0.083 [0.008]**	–0.115 [0.012]**
β	0.986 [0.002]**	0.984 [0.004]**
v	1.262 [0.023]**	1.608 [0.065]**
Nikkei225		
Mean equation		
<i>Const</i>	–0.000 [0.000]	–0.000 [0.000]
<i>S&P500(1)</i>	0.149 [0.012]**	0.100 [0.019]**
<i>US Yield(1)</i>	0.001 [0.001]	0.001 [0.002]
<i>JP Yield</i>	0.001 [0.001]	0.008 [0.003]*
<i>EXH</i>	0.008 [0.011]	0.014 [0.020]
Variance equation		
ω	–0.333 [0.038]**	–0.319 [0.094]**
α	0.154 [0.015]**	0.136 [0.026]**
γ	–0.090 [0.010]**	–0.042 [0.018]*
β	0.976 [0.004]**	0.976 [0.009]**
v	1.188 [0.019]**	1.273 [0.048]**

Note. The exchange rate is denoted as *EXH*. The notations for parameters in the conditional variance are consistent with Eqs. (2) and (3). For data definitions, please refer to main text and/or Table 17.3. Statistics with asterisks, ** (*), are significant at the one (five) percent level. Statistics in brackets are standard errors.

yield in the full sample, the Japanese bond yield is insignificant in the Japanese stock return equation. The negative relationship between the S&P500 return and US bond yield is consistent with the standard interpretation of the relationship between these variables. In other words, the higher bond yield makes investment in stocks less attractive, and thus results in a fall in demand for stocks.

Interestingly however, this negative relationship is no longer evident during a more recent sample period, and the US bond yield is no longer a significant explanatory variable for the S&P return from 1998 onwards. One possible expla-

nation of the breakdown of this relationship is the recent significant expansion in the US housing market as an alternative investment choice. Purchasing real estate is now more solidly established as an attractive option for investors in the US, and therefore the S&P may be moving in response to factors that are not captured by Eq. (4), and so the US stock market is relatively less associated with the US government bond market.

What is interesting is that the US experience is in sharp contrast to the Japanese one. In Japan, the government bond yield has no useful information in explaining its stock return in the full sample. However, since 1998, the JGB yield is positively and significantly correlated with the Nikkei225 stock return. This positive relationship may be inconsistent with standard economic theory, but it can be explained by a unique feature of the Japanese economy. During our most recent sample period, Japan experienced a severe recession and subsequent deflation. Thus, an increase in inflation is regarded as one condition for economic recovery, and indeed the BOJ implemented an accommodative monetary policy with expectations of further inflation. In this particular circumstance, high expected inflation has been regarded as a good omen for the economy and thus probably has resulted in a stronger stock market.

Finally, the exchange rate is found to be insignificant for both countries. The low correlation between stock returns and the exchange rate may be attributable to our choice of comprehensive stock data. Our data comprise stocks of both tradable and non-tradable sectors, and the stock prices for the non-tradable sector may not be affected by exchange rate movements. Furthermore, their relationship becomes less clear even for firms in the tradable sector since exporting firms are often also importing companies. In this case, while yen depreciation, for example, may help Japanese firms increase profits from increased exports, total profits may be squeezed by more expensive imports.

6. EFFECTS OF GOVERNMENT YIELDS ON STOCK MARKETS

This sub-section analyzes the interaction between stock and bond markets using the government yield equation. In the previous sub-section, bond yields are found to have influenced stock returns in some cases. Here, we examine the possibility of stock returns affecting bond yields. For this purpose, we shall again implement the EGARCH method, and this time Eq. (1) can be re-expressed as:

$$b_t = \xi_0 + \xi_1 y_t + \xi_2 y_t^* + \xi_3 b_t^* + \xi_4 s_t + \varepsilon_t \quad (5)$$

where y_t is stock returns, b_t is government yields, and s_t the exchange rate. The asterisk indicates variables for a foreign country. As before, the lagged US variables are included in the JGB equation in order to take into account the time difference between markets.

The results are reported in Table 17.5 which displays a number of interesting points. First, bond yields themselves are strongly correlated: the US (Japanese) yield is positively correlated with the Japanese (US) yield. Therefore, we confirm previous findings (Sutton, 2000) supporting co-movement in bond yields, and the increased importance of common factors as opposed to country-specific factors (Baele et al., 2004). As mentioned before, according to the term structure of interest rates, this result can be interpreted as short-term interest rates in these two countries being expected to move in the same direction. Furthermore, co-movements in bond yields may be attributable to other common components such as the term premia (Sutton, 2000) and news (Baele et al., 2004). Therefore, to a great extent, the recent European trend of market integration (e.g., Ehrmann, Fratzscher and Rigobon, 2005) can be applied to the relationship between Japan and the US.

Furthermore, as one would expect from standard economic theory, the US yield has a negative and significant relationship with the S&P500 return in the full sample. This suggests that an increase in the US yield is associated with a reduction in the S&P500 return. Along with the result in the previous sub-section that the US bond yield significantly affects the S&P500 return, we could conclude that no unidirectional spillover exists between the US bond and stock markets. And yet, a unique causality from the stock to bond markets has existed since 1998 onwards when the significance level of the US bond yield ceased in the S&P500 return equation. In this more recent sample period, the US bond yield is positively correlated with the S&P500 return. This positive relationship is consistent with the result in Table 17.4, and reflects a rise in the S&P500 price and bond yield during 1998–2000 as well as a decline in the S&P price and bond yield after the bubble burst in 2000 (Figure 17.3). The latter is exactly the same as what happened during the US stock market crash in 1987. Thus history seems to strongly suggest that at the time of a stock market crash, both the stock price and government bond yield tend to decline.

Similarly, the Nikkei225 return enters the JGB yield equation with a positive sign, suggesting that a decline in the Nikkei225 was associated with a fall in the JGB yield, which is also consistent with our finding in the previous sub-section. However, in contrast with US results from the full sample, a clear unidirectional causality exists in Japan. In recent years, the JGB contains useful information about explaining the Nikkei225 return (Table 17.4). Furthermore, our result indicates that the causality used to run in the opposite direction, i.e., from Japanese

Table 17.5
Bond Yield Equations

	1986/09/03–2005/06/01	1998/01/01–2005/06/01
US Yield		
Mean equation		
<i>Const</i>	−0.011 [0.001]**	−0.014 [0.001]**
<i>S&P500</i>	−0.214 [0.066]**	0.346 [0.125]**
<i>Nikkei225</i>	−0.084 [0.052]	−0.062 [0.087]
<i>JP Yield</i>	0.250 [0.008]**	0.342 [0.018]**
<i>EXH</i>	0.625 [0.055]**	1.221 [0.109]**
Variance equation		
ω	−2.409 [0.139]**	−2.365 [0.237]**
α	0.921 [0.058]**	0.900 [0.091]**
γ	0.104 [0.034]**	0.093 [0.047]**
β	0.648 [0.023]**	0.653 [0.040]**
v	1.209 [0.022]**	1.349 [0.039]**
Japanese Yield		
Mean equation		
<i>Const</i>	−0.010 [0.000]**	−0.010 [0.000]**
<i>S&P500(1)</i>	−0.042 [0.036]	0.044 [0.049]
<i>Nikkei225</i>	0.089 [0.035]*	0.058 [0.052]
<i>US Yield(1)</i>	0.053 [0.004]**	0.024 [0.005]**
<i>EXH</i>	0.754 [0.037]**	−0.083 [0.046]**
Variance equation		
ω	−2.011 [0.102]**	−1.856 [0.131]**
α	0.828 [0.043]**	0.763 [0.065]**
γ	0.072 [0.028]*	0.093 [0.036]*
β	0.747 [0.015]**	0.793 [0.017]**
v	1.050 [0.017]**	1.167 [0.029]**

Note. The exchange rate is denoted as *EXH*. The notations for parameters in the conditional variance are consistent with Eqs. (2) and (3). For data definitions, please refer to main text and/or Table 17.3. Statistics with asterisks, ** (*), are significant at the one (five) percent level. Statistics in brackets are standard errors.

stock to bond markets, before 1998 (Tables 17.4 and 17.5). The reverse in the direction of causality supports our expectations about the increased influence of the JGB market over the other segments of the financial market.

Finally, let us discuss the relationship between bond yields and the exchange rate. Table 17.5 shows that the parameters for the exchange rate are often consistent with the uncovered interest rate parity (UIP). The UIP suggests a negative (positive) correlation between the exchange rate and a home (foreign) yield. Thus, the exchange rate is a positive function of the US bond yield and is a nega-

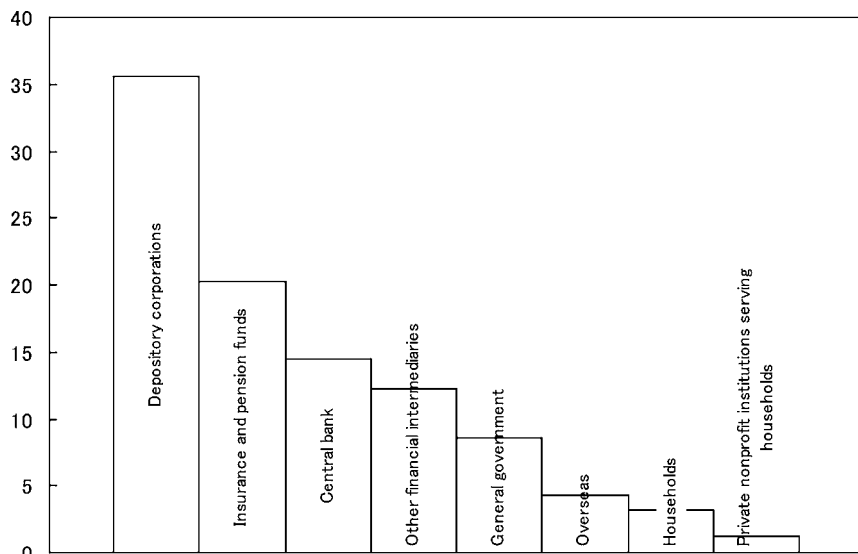


Fig. 17.5. Sectoral Holdings of JGB in December 2004 (%). Source: Ministry of Finance, Japan (2005)

tive function of the JGB yield. One exception is the Japanese yield-exchange rate relationship in the full sample. Only in this case is there a positive relationship, indicating that the yen depreciation (appreciation) was associated with an increase (fall) in the Nikkei return.

This observation can also be seen in Figure 17.3. Notably, there was an unprecedented increase in stock prices which led to the stock price bubble in the late 1980s. This stock price increase indeed co-existed with yen depreciation which became prominent after 1988. Furthermore, Figure 17.3 shows that yen appreciation co-existed with a decline in the Nikkei225 from 1990 to 1995. The fact that the exchange rate is an important determinant of bond yields, despite almost all (96%) JGBs being owned by Japanese residents, is noteworthy since exchange rate risk may not be a concern of JGB investors (see Figure 17.5).¹² Our result

¹² Despite the size of the market, JGBs are held by a rather homogeneous group of investors. In December 2004, the largest JGB holders were depository institutions (36.5%), followed by insurance and pension funds (20.6%) and the BOJ (14.6%). While some government bonds are available for individual investors, household and non-profit organizations possess only 3.2% of total JGBs. Similarly, foreign investors account for only 4.3% of the total, which is a very small percentage compared with other industrialized countries. This low level of foreign participation may be a reflection of the low credit rating of the JGB. In April 1998, Moody's rating for the government's local currency bond was Aaa, but

may confirm that long-term yields contain very useful information about future inflation and therefore an increase in the exchange rate should be expected to have higher inflation.

7. CONCLUSION

This paper has studied the integration of financial markets within and across markets using Japanese and US stock returns, government bond yields, and the exchange rate. We are motivated by the recent developments in the JGB market, one of the largest markets in the world, and think it is important to understand the influence of the JGB market and any changes it exerts over other segments in the financial market. Furthermore, it is interesting to analyze the information content of the long-term JGB yield given that the Japanese short-term interest rate is facing a lower bound of zero percent.

We provided a lot of evidence to support market integration between Japan and the US as well as within the domestic market. In short, while some results are sensitive to the sample period and countries under consideration, bond markets are generally closely linked with stock markets although their relationship seems somewhat weaker than stock market linkage across countries. In particular, interaction between the stock and bond markets in the US has been very high. In the case of Japan however, the JGB yield has been increasingly influential over the Nikkei225 returns only since 1998. In addition, while a unidirectional causality existed from stock to bond markets in Japan before then, the direction of this causality reversed and now runs from bond to stock markets. This result seems to reflect the increased significance of the JGB market in Japan.

Finally, let me mention ways in which this research might be extended. First, while we focus solely on how expected values of stock returns and bond yield interact, one could extend our analysis by evaluating market interaction based on the volatility criterion. Such an approach has been adopted by other researchers (see Section 2) in a different context, but was not explored in this paper. Secondly, the same analysis could be conducted in a multivariate context. In order to ease computational difficulties, this paper analyzes individually the behaviours

was successively downgraded thereafter, becoming A2 in May 2002. In the A2 group, there are many emerging markets such as Cyprus, Greece, Israel, Mauritius, Poland, and South Africa, but no other industrialized countries. Since the JGB's rating was substantially lower than those for other G7 countries, it provoked an unusual request from the Ministry of Finance to major credit agencies (Moody's, Fitch, and the S&P) calling for explanations of their criteria for downgrading. See the homepage of the Ministry of Finance (<http://www.mof.go.jp/jouhou/kokusai/p140523me.htm>, <http://www.mof.go.jp/jouhou/kokusai/p140523fe.htm>, and <http://www.mof.go.jp/jouhou/kokusai/p140530se.htm>).

of stock and bond markets. However, as demonstrated here, there are many occasions where no unidirectional causality is found between markets. Therefore, in order to capture cross-sectional information, it would be more appropriate to model all markets simultaneously.

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